ENNIS, CATHERINE DUNNINGTON. The Development of a Multi-skill Test in Lacrosse for College Women. (1977)
Directed by: Dr. Sarah M. Robinson. Pp. 112.

The purpose of this study was to examine the development of a test to provide an objective measure of selected lacrosse skills. The items for the test were chosen on the basis of relevance, objectivity, and discriminating power. Lacrosse skills meeting these criteria included dodging, picking up, pivoting, throwing, and shooting. In addition, speed and agility, important characteristics of lacrosse, were incorporated in the test. Skills were combined in a multi-skill format in an attempt to approach the game situation and to decrease the time required for testing. The test required skill and knowledge of lacrosse technique and the flexibility to adapt skills to new situations. Test directions did not require specific skills, but encouraged the completion of the total task as quickly and as skillfully as possible.

One hundred and five players from five Virginia colleges served as subjects for the study. Varsity lacrosse coaches from each college rated their players into five levels using a revision of the Hodges' Rating Scale. Coaches rated players two weeks prior to testing.

Ninety-five subjects were randomly selected from the population of players tested and their test scores submitted to statistical evaluation. Time scores comprised the data for the study. Scores were analyzed by the analysis of variance repeated measures design with fixed effects and subjects nested within level. The Statistical Analysis System computer program was utilized to determine the effects of the relationship of skill level to the trial performance of test

subjects. Post hoc comparisons of group means were computed for the data when the analysis of variance procedure indicated that the F test was significant at the .05 level. The coefficient of reliability between levels and between trials was R = .89 and R = .78, respectively. The Statistical Analysis System computer program was used to compute the Kendall rank correlation coefficient, tau, between coaches' ratings and mean time scores. The coefficient of validity computed with this statistic was r = .66. The Statistical Package for the Social Sciences computer program was used to compute a discriminant analysis of the test data. The discriminating variable, time, was used to classify subjects into level groups. The discriminant analysis classified correctly 52.7% of the test subjects as defined by coaches' ratings.

The test was found to discriminate two levels of lacrosse skill without the use of complex equipment when used by a trained examiner who was not a lacrosse expert. The revised Hodges' Rating Scale was also found to be an effective rating devise when used by experienced lacrosse coaches to rate their own players. Within the limitations of the present study, the multi-skill format was found to provide a more relevant setting for the evaluation of lacrosse skills than did the battery design as utilized by previous lacrosse investigators.

# THE DEVELOPMENT OF A MULTI-SKILL TEST IN LACROSSE FOR COLLEGE WOMEN

by

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Approved by

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APPROVAL PAGE

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# CHAPTER I

## INTRODUCTION

Tests of physical performance may be constructed as formative or summative evaluations of movement. Formative evaluations emphasize the process or technique which the individual uses to complete the movement. Summative evaluations place an emphasis on the end result of the movement. A summative evaluation is directed toward a general assessment of the degree to which goals have been attained. Several skills or concepts should be presented prior to summative evaluation (Bloom, Hasting, & Madaus, 1971).

Ebel and Hill (1959) state that essential qualities of a good test are relevance and discriminating power. Relevance is based on topical coverage, emphases on the program, and quality of the test item. Relevant items are based on specific objectives and not on program content. Relevant test items emphasize important long range achievements rather than incidental information (Dietz & Beryl, 1940). Items with discriminating power are those which a well qualified subject accomplishes successfully. The discriminating power of an item depends on the objectivity of the item and the ability of that item to evaluate the proposed objectives (Ebel & Hill, 1959).

Individuals attempting to accomplish a specific movement goal frequently perform with strikingly diverse techniques. Ley (1960) has suggested that individuals attempting to perform skills often make variations which are quite successful, but contrary to the descriptions

given by the instructor. "Combine this with the fact that there is a great deal of discrepancy between what people do and what they think they do . . ." (p.6) and it becomes difficult to develop an all encompassing scale or set of guidelines to evaluate absolute technical form.

Lawther (1977) observes that as performers reach higher skill levels, even greater variations in technique occur. This may result from a diversity of perceptual, physiological, and neurological abilities. Basic fundamental experiences and breadth of movement vocabulary also affect the potential development of the performer (Harrow, 1972). Allowances for this variation in performance may be provided by an emphasis on the product. Safrit (1973) states that, for players beyond the beginner level, a satisfactory product indicates little need to measure process.

Bloom et al. (1971) recommend that test construction should be preceeded by the development of a table of specifications for the subject area and skill level concerned. Tests given to performers in a variety of skill levels should reflect these specifications for performance. Skill levels may be discriminated through a progressive scale thus challenging highly skilled performers to approach their physiological and psychological limitations (Lawther, 1977).

## Significance

Women's lacrosse is a sport in which limited efforts have been made to devise accurate instruments to measure the product of skill acquisition. The majority of these tests have consisted of independent

subtests in which investigators have attempted to separate the sport into isolated skills. Investigators (Hodges, 1967; Wilke, 1967) have found limited success when combining subtests into reliable batteries. The Hodges and the Wilke instruments require complicated equipment in the form of targets and catapult devices, rendering the tests impractical in the teaching/coaching situation.

For the purposes of this study, characteristics of a desirable lacrosse test were first defined. Major criteria included the ability of the test to incorporate skills and abilities relevant to the game of lacrosse, to discriminate levels of lacrosse skillfulness, and to objectively measure the product of lacrosse skill acquisition. Further criteria included the ability of the test to approach the game situation, to eliminate the need for complex equipment, and to reduce the time required for testing. Lacrosse skills meeting these criteria included picking-up, dodging, pivoting, throwing, and shooting. In addition, speed and agility, important characteristics of lacrosse, were incorporated in the test. A multi-skill format was chosen in an effort to approach a game situation. This format was also selected in an effort to limit the total time required for testing.

## Statement of the Problem

The purpose of this study was to devise a test that would provide an objective measure of the product of lacrosse skills. The study attempted to answer the following questions:

1. Is the test a valid measure of lacrosse skill?
    a. Does the test discriminate two levels of lacrosse skill?
    b. Can concurrent validity be established?

2. Does the test measure levels of lacrosse skill without the use of special target or catapult devices?

3. Does the test reliably measure lacrosse skill when used by a trained examiner who is not a lacrosse expert?

## Definition of Terms

The following definitions were used for this study:

Skillfulness. "The ability to achieve a goal with maximum certainty, often with a minimum outlay of time and energy" (Knapp, 1963, p. 4).

High level player. A player who performed with skillfulness. The performance was accurate, efficient and consistent.

Low level player. A player who performed with limited skillfulness. The performance was hesitant and inconsistent.

## Assumptions

The following assumptions have governed this study:

1. The product of skill acquisition was the result of the process.

2. The test required maximal effort of the participants.

3. The subjects performed with maximal effort.

4. Little change in player ability occurred between the time of categorization and testing.

5. Coaches' evaluations of their players were accurate.

6. The Hodges' Rating Scale has logical validity and would be an acceptable criterion measure.

## Scope of the Study

This study was limited to a product measure of women's lacrosse skill. The subjects consisted of one hundred and five players of various skill levels currently under the instruction of varsity intercollegiate lacrosse coaches at five Virginia colleges. Data were collected between March 30, 1977, and April 18, 1977.

# CHAPTER II

# REVIEW OF LITERATURE

A review of literature was undertaken to determine the extent of research in three areas: lacrosse technique, lacrosse skill testing, and skill acquisition. The first section examined published literature concerning lacrosse technique to determine basic skills appropriate for lacrosse skill testing. Appendix A presents a summary of skills recommended at the beginner level. The second section reviewed the extent of research completed in lacrosse skill testing. A summary of skill test literature appears in Appendix B. Specific skills, subtests, and indications of statistical analysis may be determined from Tables 6, 7, and 8 (Appendix B). General characteristics of progressive levels of skill acquisition were presented in the third section of the review.

## Lacrosse Technique

Bloom et al. (1971) state that test construction should be preceded by the development of a table of specifications for the subject area and skill level involved. A test designed to discriminate levels of skillfulness should include items which high level players perform efficiently and low level players perform less efficiently (Ebel & Hill, 1959). To ensure a positive experience for low level performers, efforts should be made to encourage skills which these players may perform with some degree of confidence (Harrow, 1972).

A review of lacrosse technique literature was undertaken to determine skills appropriate at the beginning level.

In 1934, Newbold and Lockley emphasized the necessity for the beginner to "receive and pass the ball whilst running in any position and at any moment" (p. 11). Their description of the grip stated that the right hand should be placed at the collar of the stick for attack players and the left hand at the collar for defense players. This technique provided dominant hand control when shooting for attack and added reach and control when intercepting for defense. Newbold and Lockley emphasized speed of the player when cutting and picking up the ball, and rhythm and flexibility when cradling, catching, and passing.

Mackey (1950) emphasized the need for beginners to develop a correct grip and a vertical cradle. As these techniques were developed, emphasis shifted to the skills of catching and picking up the ball. Dodging, pivoting, body checking, and crosse checking were considered 'late beginner' skills. Mackey did not specifically refer to the skill of passing. However, details of the overarm action were included in the description of goal shooting.

Stenning (1952) combined an emphasis on the grip and the swing of the cross to describe the beginning cradling movement. The skills of picking up, catching, and body checking were included in beginner technique. Stenning referred to pivoting as 'body twisting.' This skill was taught as an extention of the cradle and as an exaggeration of the dodge.

Conklin (1958) placed an emphasis on four basic lacrosse skills: cradling, catching, picking up, and body checking. Although reference

was made to the pass, this skill was not described in detail. Lacrosse Playing and Coaching by Boyd (1959) included specific instructions for ten basic lacrosse skills: cradling, catching, passing, picking up, body checking, crosse checking, shooting, dodging, pivoting, and cutting. Boyd emphasized the need for basic technical development and for the application of technique drills to the game situation.

Reeson (1964) in the monograph, Know the Game - Lacrosse, reiterated these skills with an emphasis on application. Mushier (1965) presented discussion to support the use of a strong top hand for controlled play. This technique was applied to cradling, passing, body checking, dodging, and pivoting. In 1969, Phillips presented a brief summary of technique for beginners at the secondary school level. Discussion was limited to specific comments on cradling, catching, picking up, and passing. Body checking and crosse checking were described with an emphasis on defensive positioning and footwork.

Delano (1970) discussed ten lacrosse skills: cradling, catching, passing, picking up, body checking, crosse checking, shooting, dodging, pivoting, and cutting. She emphasized the need to perform these skills 'on the move' and provided drills to support this point. Lewis (1970) suggested that the game be presented as a 'whole.' Skills were discussed as a natural extention of the game situation. Players dropping the ball were encouraged to 'scoop it up.' The instructor was to suggest necessary technique only when it did not naturally occur (p. 9). Skills of cradling, catching, passing, picking up, body checking, crosse checking, shooting, and dodging were described with an emphasis on the 'natural' approach.

Bixler (1972) emphasized technical points frequently overlooked by players of all skill levels. Statements defined as skill tips were provided for the grip, cradle, pivot, catch, and throw. Additional comments were provided for the execution of body checking, crosse checking, and goal shooting. Poindexter and Mushier (1973) included a chapter on lacrosse in their book, Competitive Team Sports for Girls and Women. Skills described included catching, passing, picking up, body checking, shooting, and dodging. Skill descriptions were brief and concise with an emphasis on moving drills and application of techniques to the game situation. Kosstrin (1976) emphasized refinement and control of lacrosse technique. Kosstrin examined the skills of cradling, catching, passing, picking up, body checking, crosse checking, pivoting, and cutting. She emphasized the need to teach controlled, skillful play to avoid injury.

The basic skills of cradling, catching, passing, dodging, throwing, body checking, picking up, and shooting were recommended by the majority of authors at the beginning level. In addition, agility, flexibility, and speed were considered foundations for efficient performance. Skills introduced at the beginner level were performed at all subsequent skill levels. These lacrosse skills possessed inherent discriminating power (Ebel & Hill, 1959) which upheld to their inclusion in a test constructed for a variety of levels of lacrosse skill.

## Lacrosse Skill Testing

Several attempts have been made to objectively measure lacrosse skills and playing abilities. These tests provided a guideline and a basis for comparison of present effort in test construction. The literature in lacrosse skill testing was reviewed in an attempt to identify specific skills, subtests, and statistical methodology.

The first lacrosse skill test battery was developed by Netter (1935) to measure the fundamental skills of male college lacrosse players. Four subtests were developed for each of the skills of catching and shooting. Two subtests were developed for the skill of passing. Subtests within each skill were distinguished by the spatial location from which the player caught, passed, or shot for goal. For the catching test, the examiner threw the ball to each subject. For the passing test, the subjects were required to pass accurately to other subjects participating in the shooting test, who in turn, shot for goal. Criteria for the passing test included the 'shooter's' ability to catch, control the ball, and shoot for goal within the limits of a restraining line. Criteria for the shooter included specific target areas of the goal cage guarded by an 'active' goalkeeper.

Pre and post tests were given at the beginning and the end of each lacrosse season for four successive years. Scores were computed using the Pearson-product moment correlation on the pre and post test scores for each year. Resulting coefficients were further compared for two year periods. Final correlations compared scores

for each series of two years. Subjects included thirty-seven attack players. Reliability coefficients ranged from r = .93 to r = .91 for passing, r = .91 to r = .79 for shooting, and r = .97 to r = .86 for catching. Construct validity was established by comparing each individual's scoring statistics for that season with test scores in each subtest. The validity coefficients computed using the Pearson-product moment method were r = .66 for passing, r = .60 for catching, and r = .57 for shooting.

Waglow and Moore (1954) developed a skill test battery for college men. The battery consisted of four tests measuring six men's lacrosse skills: shooting, throwing, scooping, cradling, weaving, and dodging. The Goal Shooting test measured players' ability to score from twenty yards in front of the goal. The Throwing test was designed to measure throwing accuracy from different angles. This test utilized a restraining line forty yards from a stationary wall target. The Scoop and Weave test measured players' ability to pick up a stationary ball and cradle around barriers. The score was based on a time variable. The Dodging test was constructed to measure time when dodging barriers. The battery was not subjected to statistical evaluation.

Barrett (1959) developed a wall volley test to measure the general lacrosse ability of college women. The skills of catching, cradling, and throwing were utilized to measure lacrosse ability. The test consisted of a thirty second wall volley from a thirty-five foot restraining line. Players were evaluated by three judges utilizing a six-point rating scale. Subjects were fifty-five college

women of varying abilities. The reliability of judges' scores was r = .906 using the Kuder-Richardson Formula method. The Pearson-product moment method was used to reveal a test reliability of r = .86±.02. Spearman rank correlation method was used to compare raw scores with judges' ratings. A validity of r = .71±.04 was established for this test.

Skill achievement of beginning lacrosse players was measured by Lutze (1963). Fifty-four high school students were evaluated on the skills: goal shooting, throwing, catching, picking up, dodging, and pivoting. The Goal Shooting test measured shooting accuracy from three angles. The subtest utilized a long bounce shot at a stationary target. A Pass and Catch test consisted of a thirty second wall volley test to measure throwing and catching ability. The Pick up, Pivot, and Dodge test measured the subjects' ability to pick up a stationary ball, dodge three obstacles, and return to the starting line. General playing ability was evaluated by three judges using a five-point scale.

Correlations were computed between judges one and two, one and three, and two and three. The Pearson-product moment method produced correlations of r = .84, r = .82, and r = .75. Reliability coefficients for each test were increased by the Spearman-Brown Prophesy formula. Coefficients ranged from r = .77 to r = .79 for the three angles analyzed in the goal shooting test. A coefficient of r = .88 was correlated for the Passing test, and r = .82 for the Pick up, Pivot, and Dodge test. Validity coefficients correlating the sum of trials with judges' ratings produced coefficients of r = .28 to r = .11 for

the Goal Shooting test, r = .57 for the Pass and Catch test, and r = .20 for the Pick up, Pivot, and Dodge test. Lutze suggested that the low statistical evaluations were the result of an insufficient number of subjects, lack of motivation, and disagreement of the judges.

A skill test for the overarm pass was developed by McGowan in 1965. The test measured the velocity of a 'good pass' and the 'optimal' area in which to catch a pass. Passes were timed from a restraining line to a stationary wall target. If the speed of the pass fell within prescribed limits, the point value of the target block was doubled. The test was subject to limited experimentation. Statistical data were not reported.

Wilke (1967) developed a test battery of beginning lacrosse skills for college women. The battery measured passing, catching, picking up, and dodging. Subjects consisted of one hundred and forty-three college freshmen in beginning lacrosse classes. The Passing test was designed to measure the subjects' ability to pass ahead of the receiver. The ball was thrown on the run from a release line twenty-four feet from the target. The target was marked in relation to potential catching area surrounding the head of a fixed lacrosse stick. The score for this subtest equaled the sum of the scores for six trials. The Catching test measured the players' ability to catch on the left and on the right. The test utilized a ball throwing catapult to increase objectivity. Subjects, running in a three foot lane, caught the ball and continued running and cradling until reaching the finish line. Subjects then repeated the pattern in the opposite direction. One trial consisted

of catching once on the right and once on the left. The score was the total of successful catches. The Pick up, Run, and Dodge test measured subjects' speed and cradling ability when dodging obstacles. Subjects picked up a stationary ball, dodged three chairs, pivoted, and returned, dodging the original three chairs. The test consisted of three timed trials.

Reliability for the subtests was established by the test-retest method. In addition, the odd-even method was used to evaluate the Passing and the Catching tests. The result of each test was stepped up with the Spearman-Brown Prophesy formula. The Passing test yielded a reliability coefficient of $r = .24$ using the test-retest method. The odd-even method revealed a coefficient of $r = .47$ for both the first and second administrations. A coefficient of $r = .78$ was obtained when the trials were increased to twelve. The Catching test produced a coefficient of $r = .46$ using the test-retest method. The odd-even method revealed a coefficient of $r = .29$ for the first administration and $r = .54$ for the second. Coefficients of $r = .62$ and $r = .83$ were obtained by increasing the number of trials to twelve. The Pick up, Run, and Dodge test revealed a coefficient of $r = .62$ when the sum of scores of three trials were used.

Validity was determined through a correlation of the sum of the judges' ratings and the scores on the first and second administrations of the Passing and the Catching tests and the best score of three trials on the Pick up, Run, and Dodge test. The first administration of the Catching test revealed a coefficient of $r = .35$ when correlated

with the judges' ratings. A coefficient of r = .40 was obtained for the second administration. The Passing test produced coefficients of r = .17 and r = .04 when correlated with the sum of judges' ratings. Validity for the Pick up, Run, and Dodge test was found to be r = .45 when the best score was correlated with judges' ratings for the first administration. The second administration revealed a coefficient of r = .38. Wilke concluded that the Pick up, Run, and Dodge test was a fairly reliable measure of lacrosse ability. However, more trials of the Passing and the Catching tests were needed to establish their reliability. Validity of all subtests was considered too low to be judged a valid measure of lacrosse playing ability.

In 1967, the Division for Girls and Women's Sports sponsored a lacrosse skills testing project as a part of the American Association for Health, Physical Education and Recreation's Sports Skills Testing Project. The lacrosse skill tests, under the direction of Mushier, included eight tests to measure the skills of throwing, catching, goal shooting, cradling, picking up, and dodging. The Lacrosse Throw for Accuracy test consisted of a stationary wall target twenty feet from a restraining line. The target consisted of three concentric squares labelled with point values. The score of the test was the total points scored on twenty throws.

The Lacrosse Throw for Distance test consisted of an overarm throw from a twenty foot throwing zone. Throws were measured to the nearest foot perpendicular to the restraining line. The best score of four trials was recorded. The Lacrosse Catching test relied on a test

subject to act as a 'thrower.' The thrower, utilizing an underarm motion, tossed the ball over a ten foot rope into a catching area. The subject, running from a starting line, attempted to catch and control the ball for a minimum of three seconds. Each subject performed ten trials from each of three starting lines. A trial was repeated if the throw was improperly executed.

The Lacrosse Shot for Goal for Accuracy test measured the players' ability to shoot on the run at a stationary target. Three separate angles were used. The score was the point value of the target area hit on each trial. The score for the test was the sum of thirty trial scores. The Run and Cradle for Speed test was conducted in two parts. In the first part the subject ran thirty yards carrying a lacrosse stick 'by any means.' In the second part the subject repeated the run "cradling a lacrosse stick and ball" (p. 8). The score on each part was based on time. Mushier noted that the difference between the two timed scores was an indication of the efficiency of the lacrosse cradle.

The Lacrosse Pick Up of a Rolling Ball test measured players' ability to collect a ball within a six foot square area. A test subject, acting as thrower, attempted to roll the ball at a 'normal' rate so that it reached the pick up area in approximately three seconds. The player, running from the starting line, attempted to pick up and control the ball for a minimum of three seconds. The test consisted of five trials from each of four starting positions. A trial was repeated if performed incorrectly. The score was the total number of pick ups performed correctly in twenty trials.

The Lacrosse Repeated Catch and Throw test was a thirty second wall volley test. The score was the total number of legal hits in three trials. The Lacrosse Dodge and Run test measured the player's ability to cradle and dodge five obstacles. A player, cradling the ball, dodged each obstacle, pivoted, and returned, dodging the original three obstacles. The score of the test was the time necessary to complete one trial. The Lacrosse Skills Test Manual has not been published. Statistical data for these tests are not available.

A battery of tests was developed in 1967 by Hodges. This study included the construction of a knowledge test and a skill test battery for college women. Hodges' skill test battery measured the skills of passing, catching, cradling, goal shooting, picking up, pivoting, and dodging. A Wall Volley test was utilized to measure passing and catching. This test was revised from Mushier's (1967) Lacrosse Repeated Throw and Catch test to include three, sixty second trials. The Pick up, Dodge, Turn, and Run test was revised from Wilke's (1967) Pick up, Run, and Dodge test. Subjects were required to pick up a stationary ball, dodge three obstacles, turn, and return, dodging the original three obstacles. The Shooting test was revised from Mushier's (1967) Lacrosse Shot for Goal for Accuracy test. The test measured subjects' ability to shoot at a stationary target. Three shooting angles were used. The test consisted of ten trials from each angle. The score was the sum of thirty trials.

Hodges developed a comprehensive five-point rating scale to validate test items. The rating scale evaluated players on eight basic

lacrosse 'skills:' cradling, picking up, catching, passing, evading opponents, shifting from offense to defense, field positioning, and body control (p. 9).

Reliability coefficients were established using the Pearson-product moment method. Test-retest scores for the Wall Volley test revealed a coefficient of $r = .85$ for the best of three trials and $r = .88$ for the sum of scores. The Pick up, Dodge, Turn, and Run test achieved a reliability coefficient of $r = .83$ using the best of three trials and $r = .63$ using the sum of scores. The Shooting test produced coefficients too low to warrant additional statistical computations. Validity coefficients reflected a comparison of average judges' ratings with the best scores and the sum of scores for each skill test. The validity coefficient for the Wall Volley test was $r = .40$ for the best score and $r = .37$ for the sum of scores. The coefficient for the Pick up, Dodge, Turn, and Run test was $r = .47$ when both the best scores and the sum of scores were compared with judges' ratings. The validity coefficient for the Shooting Accuracy test was $r = .17$ to $r = .04$. Hodges suggested that low validity coefficients were a result of the inconsistent ratings of two of the judges and the complexity of the rating scale. Hodges concluded that, for the purposes of her study, judges' ratings could not be considered a good criterion for measurement of lacrosse playing ability. Hodges further concluded that the validity coefficients for skill tests within the study "could be misleading" (p. 58).

Hicks (1971) developed an achievement test battery for beginning college women. Five subtests were included. The Lacrosse Multi-Skill

test involved picking up a stationary ball, cradling, dodging, and throwing for distance. The Lacrosse Throw for Distance test was similar to Mushier's (1967) subtest. The Goal Shooting test involved cradling and shooting on the run. The Wall Toss test was a wall volley requiring an underhand toss. The Wall Rally test followed the same format as the Wall Toss test requiring an overhand throw.

Hicks developed a rating scale to measure general lacrosse playing ability. The categories of the rating scale included crosse control, accuracy of passing, consistency of catching, and body control. Ratings were used as a criterion measure to establish the validity of the achievement tests. Three judges rated forty-five subjects in three intraclass game situations to provide greater observation time. Tests were administered by trained student assistants. A general warm up was given prior to testing; however, subjects did not receive practice periods specific to subtest-related skills.

Pearson-product moment coefficients to determine interjudge correlations ranged from $r = .51$ to $r = .58$. Intraclass analysis of variance produced a combined judges' reliability coefficient of $R = .77$. Stability of the tests within the battery was computed through Pearson-product moment odd-even design and stepped up with Spearman-Brown prophesy formula based on twelve trials. Estimates of stability ranged from $r = .95$ for the Lacrosse Throw for Distance test to $r = .26$ for the Goal Shooting test. Pearson-product moment for test-retest results ranged from $r = .89$ for the Lacrosse Throw for Distance to $r = .01$ for the Goal Shooting test. Validity coefficients utilized the Pearson-product moment method to compare judges' scores with the sum of the

twelve trials for each test ranged from r = .66 for the Lacrosse Multi-Skill test to r = .15 for the Goal Shooting test. The combination of the validity coefficients for the Lacrosse Multi-Skill test and the Lacrosse Throw for Distance test increased the validity coefficient to .69. The intercorrelation between these two tests was r = -.63. A multiple regression equation:

Y = -.08 Multi-Skill test + .01 Throw for Distance

was computed for the battery. The multiple regression equation weighted the raw test scores to provide an estimate of playing ability. The negative intercorrelation coefficient indicated the extent to which the subtest measured unique components of lacrosse playing ability.

Rayfield (1972) utilized a revision of Hodges' Shooting Accuracy test to determine the effects of selected angles and distances on shooting accuracy of the side arm shot in men's lacrosse. Subjects received fifteen trials from three shooting angles. A stationary target consisting of three concentric circles was attached to the front of a lacrosse goal. Balls were placed in water to facilitate scoring. Subjects were instructed to shoot 'on the run' at distances of ten and fifteen yards.

The Wilcoxen test was used to determine t-values for angles and distances. The subjects included sixteen right-handed male high school lacrosse players. At ten yard distances, t-values of 6, 15, and 6 were computed between right and center, center and left, and right and left positions, respectively. At fifteen yard distances, t-values of 25, 21, and 15 were computed between right and center, center and left, and

right and left positions, respectively. All scores at both distances were significant at the .05 level. The greatest accuracy was noted from the left position, followed by the center and the right positions. This conclusion was confirmed at both the ten and fifteen yard distances.

Hopkins (1973) developed a Wall Volley test to measure the stick handling ability of skilled male college players. The test placed a dual emphasis on accuracy and speed. Subjects shot at a wall target composed of three concentric circles. An additional aspect of the test required that subjects alternate right and left hands at the top of the stick for each successive throw. Subjects caught the ball with their right hand at the top, switched hands, and completed the next toss and catch with the left hand at the top of the stick. The test emphasized a 'redirectional' or 'quick stick' approach frequently used to eliminate the cradle when catching and throwing. Each subject performed six, thirty second trials. The point value of each target hit was recorded. The final score was the sum of trials five and six.

The analysis of variance statistic was used to compute the intraclass correlation coefficient of $R = .97$. This coefficient was significant at the .05 level. Concurrent validity was determined by comparing the ranking of the subjects on the test with the rating of the judges, using a revision of the Hodges' scale. The Spearman-Rank Order, rho, correlation revealed a coefficient of $r = .65$. A t-ratio was computed to determine the construct validity of the test. The scores of the ten highest ranked players were compared with the scores of the ten players ranked lowest by the Hopkins test. A critical t-ratio of 5.2991 confirmed the construct validity of the Hopkins test.

For the purposes of this study, characteristics of a desirable lacrosse test were defined. Major criteria included the ability of the test to incorporate skills and abilities relevant to the game of lacrosse, to discriminate levels of lacrosse skillfulness, and to objectively measure the product of lacrosse skill acquisition. Further criteria included the ability of the test to approach the game situation, to eliminate the need for complex equipment and, to reduce the time required for testing. A review of skills relevant to the game of lacrosse at the beginner level identified the skills of picking up, dodging, body checking, pivoting, throwing, and shooting. In addition, the abilities of speed and agility were considered important characteristics of lacrosse.

The multi-skill format utilized within the subtests incorporated picking up and dodging skills in an effort to reproduce a game-like situation. Reliability coefficients of $r = .82$ for Lutze's Pick up, Pivot, and Dodge test, $r = .83$ for Hodges' Pick up, Dodge, Turn, and Run test, and $r = .63$ for Wilke's Pick up, Run, and Dodge test strengthened the acceptability of this format. Hicks presented revisions of the multi-skill approach which facilitated its use. In addition, the ability of this format to decrease testing time encouraged the inclusion of more items than had been previously incorporated into a multi-skill approach.

Subtests requiring goal shooting for accuracy reconfirmed the importance of this skill within the game situation. Barrow and McGee (1971) have recommended that the number of trials be increased when

accuracy was the required product. Both the Hodges and the Wilke instruments reported low correlations on subtests of shooting accuracy with limited trials. These tests measured shot placement as a criterion of accuracy. On the basis of these findings within the literature, it was concluded that goal shooting within a multi-skill format must compromise the criterion of ball placement.

It was the purpose of the present study to develop a test to discriminate levels of lacrosse skillfulness. Rayfield's study revealed that the degree of difficulty for right-handed players using a side arm shot was increased as the players were forced to shoot from the right side of the goal. It was, therefore, concluded that high level players should be able to shoot with greater accuracy from the right side of the goal than should low level players.

The objectivity of the instrument was considered an important criterion in test development. The objectivity of subtests has been found to decrease when subjects were allowed to control the testing situation (Barrow and McGee, 1971). The utilization of a subject or an examiner as a thrower, as in Mushier's Lacrosse Pick up of a Rolling Ball test and Lacrosse Catching test or in Netter's tests for Passing and for Catching, was found to contaminate the testing situation. The review of skill test literature identified skills conducive to objective evaluation. These skills were cradling, picking up, dodging, pivoting, throwing, and catching. Barrow and McGee have asserted that the objectivity of the validation process may be limited by the use of judges and rating scales. Lutze, Wilke, and Hodges reported that

limited viewing time, ambiguity of criteria, and disagreement of the judges contributed to the low validity scores of subtests and test batteries, confirming in lacrosse the Barrow and McGee position.

## Skill Acquisition

Lawther (1977) stated that the physical performance of players within specific sport skills was based upon individual perceptual, physiological, and neurological development. The extent to which performers were able to attain high levels of skill was subject to limitations imposed by musculature and nervous system as well as by the specific characteristics of the activities, themselves.

Fitts and Posner (1967) suggested that the accuracy and consistency of individual processes were reflected in the proficiency levels of performers. Skilled behavior was organized for a purpose. This goal oriented behavior was dependent on the utilization of sensory feedback to determine complex spatial and temporal characteristics of an activity. Each action was dependent on the comparison of feedback with a mental image of performance to determine the appropriateness of the response.

Harrow (1972) suggested that the degree of proficiency that learners were capable of achieving in a particular skilled movement may be divided into five levels: fundamental, beginner, intermediate, advanced, and highly skilled. The degree of proficiency represented a continuum of skill mastery (p. 84). Learners began with basic movement patterns which formed the foundations for skill. Learners at the beginner level exhibited some degree of confidence as they attempted

to imitate new movement patterns in trial and error learning. Performers who were successful when integrating basic patterns into a movement vocabulary were capable of modifying these patterns to form the foundations for a variety of skilled movements. Intermediate learners began to adjust their responses in light of greater awareness of proprioceptive feedback. At this stage, learners began to minimize the amount of extraneous movement needed to perform an activity.

Harrow pointed out that learners at the advanced level exhibited complete confidence and performed skilled movement efficiently. Advanced learners performed consistently and were above average when compared with performance of peers. Harrow stated that performance superior to that of peer group expectancy was characteristic of advanced level players. Highly skilled performers were totally involved in the learning experience. Performance at this level was directly influenced by physical factors such as body structure and body function. Acuity of sensory modalities and perceptual abilities also influenced highly skilled performance.

Harrow stated that success in skilled movement may be determined by perceptual and physical abilities, past learning experiences, and efficient development of reflex and basic fundamental movements. Motivational and aspirational levels, as reflected by intensive practice schedules, directly affected skill learning and retention. Hebb (1961) suggested that underlying movements in advanced skill learning were familiar to the superior performer. These movements were easily associated with learned skills to provide quick adjustment.

Lawther (1977) observed that patterns for similar movements became highly individualized at advanced skill levels. Athletes performed with individual styles as reflected by their acute perception of spatial and temporal aspects of the skill. At the expert stage variability of form among individuals was great. This was especially evident in open skills. Individuality was the result of differences in strength, speed, and endurance. Additional explanations were attributed to diversity in background, neurological response rate, reflex time, and size and length of anatomical levers. Lawther pointed out that speed of response was also affected by performers' ability to "change from exteroceptive to proprioceptive monitoring by anticipation and expectancy. Multi-modal stimuli produce responses faster than single sense stimuli" (p. 128).

Lawther identified characteristics of advanced performers which allowed individualistic styles to be successful. Advanced performers were able to adapt skills to their individual abilities, resulting in the elimination of excess movements which wasted energy. These performers were able to adjust their emotional state to avoid wasted energy through tenseness. A spillover of energy into antagonistic muscles resulted in uncontrolled or inefficient movement. The control of excess movement and energy provided the physiological basis for the fluidity and control of the advanced performer (Cratty, 1973).

Negative adaptation or the ability to ignore stimuli or distractors was present in varying degrees in highly skilled performers. Lawther pointed out that the higher the level of skill of a performer,

the greater the ability to concentrate on relevant cues. Therefore, many of the extraneous stimuli in the environment, which often distract the beginning performer, may not have registered as stimuli for the advanced player.

Advanced players possessed the ability to correct errors in their performances with little or no extrinsic feedback. Performers at this level focused on the error, noted its origin, and adjusted their performance to correct it. Additional practice served to strengthen new responses so that they were quickly incorporated into the general skill vocabulary (Lawther, 1977).

Most competitive sports require a variety of skills. Advanced performers in complex sports have been found to possess a variety of movements from which to chose. Players were experienced in skill selection and were capable of integrating new skills into their movement patterns. Advanced performers were able to time movements precisely to coincide with the actions of teammates and opponents. Individuals who required time to plan responses before acting on rapidly appearing cues were usually too late to be successful. The hesitation of response was typical of the beginning performer. Responses must have been reduced to the automatic level before individuals could move to a higher level of competition (Lawther, 1971).

It was a purpose of the present study to discriminate skill levels of women lacrosse players. A review of literature was undertaken to distinguish the general characteristics of high level performers from those of low level performers. These general characteristics were

considered applicable to all sports; therefore, no attempt was made to isolate characteristics of high and low level performers within specific sports.

Ebel and Hill (1959) asserted that items with discriminating power were those which high level performers completed successfully and low level performers completed less successfully. Harrow (1972) stated that the success of physical performance was dependent on the perceptual, physiological, and neurological development of the individual. It was concluded that items containing discriminating power within physical skills were those which allowed individualistic styles, encouraged adaptability, necessitated concentration on relevant cues, and rewarded intrinsic correction of errors. Further criteria of discriminating items required consistent performance and rewarded performances characterized by efficiency and minimal amounts of wasted energy. Based on these requirements, Knapp's definition of skillfulness was accepted for the present study. Skillfulness was defined as "the ability to achieve a goal with maximum certainty often with a minimum outlay of time and energy" (Knapp, 1963, p. 4). Thus, a high level player was defined as one who performed with skillfulness. The performance was accurate, efficient, and consistent. A low level player was one who performed with limited skillfulness. The performance was hesitant and inconsistent.

Contradictory situations, however, occurred when players were observed performing at advanced levels with a minimal skill proficiency. These players were quick to identify relevant cues and to act in decision making situations. They frequently altered their play to

compensate for technical deficiencies. In sports utilizing open skills, players may be highly successful with a minimum of technical development. Lawther concluded that because success in most physical events was judged in terms of results, censoring of the effective performer based on form criteria may negatively affect both the team and the player.

## Summary

A review of literature was undertaken to determine the extent of research in three areas: lacrosse technique, lacrosse skill testing, and skill acquisition. The first section examined lacrosse technique to determine basic skills appropriate for lacrosse skill testing. The skills of cradling, catching, passing, dodging, body checking, picking up, throwing, and shooting were recommended by the majority of authors at the beginning level. In addition, agility, flexibility, and speed were considered foundations for efficient performance.

The second section presented a review of the extent of research completed in lacrosse skill testing. The review revealed the importance of the multi-skill format and the necessity of compromise when measuring shooting accuracy within this format. Tests were further examined to determine the level of objectivity. It was concluded that in objective tests, subjects did not influence the testing situation. Furthermore, the validation process eliminated the problems of limited viewing time, ambiguity of criteria, and the disagreement of judges. An analysis of test results identified skills most conducive

to objective evaluation. These skills were cradling, picking up, dodging, pivoting, throwing, and shooting.

The third section reviewed the general characteristics of levels of skill acquisition. An effort was made to utilize this information when determining the characteristics of items with discriminating power. It was determined that items containing discriminating power were those which allowed for individual styles, encouraged adaptability, required concentration on relevant cues, and rewarded intrinsic correction of errors. Further criteria for discriminating items would require consistent performance characterized by efficiency and a minimal amount of wasted energy.

# CHAPTER III

# PROCEDURE

## Description of the Test

Characteristics of a desirable lacrosse test were defined for the purposes of this study. Major criteria included the ability of the test to incorporate skills and abilities relevant to the game of lacrosse, to discriminate levels of lacrosse skillfulness, and to objectively measure the product of lacrosse skill acquisition. Further criteria included the ability of the test to approach the game situation, to eliminate the need for complex equipment, and to reduce the time required for testing. Lacrosse skills meeting these criteria included picking up, dodging, pivoting, throwing, and shooting. Speed and agility, important characteristics of lacrosse, were incorporated in the test. A multi-skill format was chosen in an effort to approach a game situation. This format was also selected in an effort to limit the total time required for testing. The test allowed a diversity of technique without penalty. The directions did not require that specific skills be performed, but encouraged the completion of the task as quickly and as skillfully as possible. The test required skill and knowledge of lacrosse technique and the flexibility to adapt skills to new situations.

## Pilot Studies

The first pilot study was an attempt to incorporate test objectives into a working model. Seven subjects were chosen from the population of

known lacrosse players in the student body at the University of North Carolina at Greensboro. Three of the subjects were classified as high level performers and four subjects were classified as low level performers.

Players executed the following multi-skill task for a time score. Time began as subjects left the start/finish line. The subjects picked up a stationary ball, and turned to the left around cone 1. The subjects continued, running to the right of cone 2, the left of cone 3, and the right of cone 4. Running toward the testing goal, subjects tossed the ball above their heads twice and caught it. After completing the tosses, subjects shot for goal. The ball was allowed to bounce before entering the goal. Subjects were encouraged to shoot accurately. There was no penalty for an unsuccessful shot. However, subjects were rewarded for accuracy by a deduction in the total timed score. Subjects continued without the ball to the goal side of cone 5. Turning backwards, subjects ran around cone 6, and then forward to pick up a stationary ball beside cone 7. After rounding cone 7, subjects threw the ball twenty meters across the start/finish line. A timed score was recorded as the ball crossed the start/finish line.

One examiner acted as starter, timer, and recorder. The examiner's position remained stationary throughout the test. Additional subjects were positioned in five locations to assist in ball placement. Three subjects were positioned on cones 2, 3, and 4 to force test subjects to run around the cones. Data were not subject to statistical evaluations due to size of the sample and to the conditions of the testing field.

Three major revisions were adopted as a result of observations during the initial pilot study. First, it was noted that the primary factor determining success was speed rather than lacrosse skill. Since speed was not the variable of primary interest, the test was physically shortened without the elimination of any required items. Cone placement was changed to require greater agility while simultaneously shortening testing time. Final cone placement resulted in the formation of a fifteen foot equilateral triangle.

The second revision involved an adjustment of the starting procedure. It was discovered that a verbal starting signal confounded task performance by requiring a reaction time response. The verbal method was replaced by a subject-oriented starting procedure. Instead of responding to a starting signal, the subject was asked to begin when ready. Time began as the subject touched the stationary ball located beside cone 1. This adjustment in starting procedure also served to decrease the total timed score of the test.

The third revision was made to accommodate a change in the long throw. It was observed that the original distance of twenty meters was insufficient to discriminate levels of ability. Therefore, cone 8 was moved twenty-seven meters from cone 7. This adjustment required that the examiner move from cone 1 to a position opposite cone 8. Although this revision lengthened testing time, completion of this task required throwing skill, and was not dependent on speed.

The second pilot study concerned the application of the proposed changes suggested in the initial pilot study. The procedures in the

second pilot study utilized validity criteria to categorize subjects into levels according to a revision of the Hodges' Rating Scale. Subjects for the second pilot study included eighteen women lacrosse players currently participating in a beginning lacrosse class at the University of North Carolina at Greensboro.

The reliability of the pilot study was determined by the analysis of variance with fixed effects and subjects nested within level (Winer, 1971). Reliability coefficients of R = .44 and R = .36 were computed for between level and between trial variability (Ebel, 1951). The Kendall rank correlation coefficient (tau) was used to compare the investigator's classifications with the timed scores. The Kendall tau produced a validity coefficient of r = .34 (Siegel, 1956). Discriminant analysis was used to determine the percent of subjects correctly classified into level groups by the mean trial scores. Correctly classified with this method were 72.25 percent of the pilot study subjects (Nie et al., 1975). Raw data, mean scores, and statistical analyses are presented in Appendix C.

The second pilot study confirmed the relevance of the proposed revisions. The decrease in distance between test items required subjects to utilize lacrosse skills instead of speed. The utilization of a subject-oriented starting procedure eliminated starting problems which had confounded task performance in the initial pilot study. Finally the increase in distance of the long throw required greater throwing ability, thus increasing the discriminating power of the test item. The adjustment in the examiner's position required for

this revision was not found to limit the objective evaluation of the test subject. Low reliability and validity coefficients reflected the limited number and ability level of the subjects (Roscoe, 1971). Statistical results were not considered indicative of future success.

## Selection of Subjects

Subjects consisted of 105 players from five Virginia colleges currently under the instruction of varsity intercollegiate lacrosse coaches. Coaches were asked to categorize their players into five categories of skill performance using the revised Hodges' scale. The investigator selected schools to include a variety of skill levels within the original sample. Subjects included in this study were from Bridgewater College, James Madison University, Lynchburg College, Westhampton College, and the College of William and Mary.

## Administration of the Test

Testing occurred between March 30, 1977, and April 18, 1977. Appendix D includes a diagram of cone positioning, directions for testing and procedure for ball placement. Subjects were tested in groups of eight. This organization eliminated excessive waiting and allowed the test to be given simultaneously with the varsity practice. Twenty-four subjects were tested in a two hour period. Each subject completed three non-consecutive trials. One two hour testing period was sufficient to test at each school.

A fifteen minute period was required to set up cones for the testing situation. Directions for the test were explained and

demonstrated simultaneously to a group of eight subjects. The examiner led the subjects through the test, repeating key words for each task. The explanation emphasized tasks to be performed and the pattern for task completion. The examiner did not demonstrate the tasks and no reference was made to specific lacrosse skills. Upon completion of the first practice, subjects were encouraged to consider strategies and techniques which could be utilized to perform the test as quickly and as skillfully as possible. The subjects then received a second practice trial. Subjects were encouraged to discover the most efficient way to complete the given tasks. Directions for ball placement were then discussed. Clarification periods were included between trials for two reasons. First, a large quantity of information was presented in a short period of time. Second, clarification periods allowed a short rest and a time for questioning based on the experience gained in previous trials. As a final procedure, a test order was assigned to ensure a five minute rest period for each subject between trials.

## Design and Statistical Methodology

### Reliability

The recommendation of the American Psychological Association (1966) has led to important changes with the area of design and statistical methodology. This recommendation is applicable to measurement of physical skill performance.

Investigators prior to 1966 utilized three classes of coefficients to determine the reliability of test content and procedures. These classifications of coefficients were identified by Safrit (1973) as

"the coefficient of equivalence, the coefficient of stability, and the coefficient of internal consistency" (p. 126). The coefficient of equivalence determines the reliability of two separate but equivalent forms of the same test. It is most frequently used in written tests which are given on the same day. This form is also used in standardized tests administered to large populations and in teacher made tests for 'make-up' purposes. The coefficient of stability is used when the same test is repeated after a specific interval of time. This procedure is used to measure performance and is usually designed within a test-retest format. The coefficient of internal consistency involves the reliability of measurement items within a single test. The reliability is established by comparing one section of test items with a second section. This procedure is termed 'split-halves.' A second design for internal consistency compares the consistency of even numbered items with that of odd numbered items. The 'odd-even' procedure determines the reliability of sections of the test and suggests further analysis to determine strong and weak items (Safrit, 1973). These procedures provides an effective comparison of two sets of data. However, the methods were inappropriate when dealing with three or more data groups. These interclass designs provide little indication of sources of error within the testing procedure (Kroll, 1962).

The 1966 recommendations of the American Psychological Association suggested the utilization of statistical methods which would provide a more accurate indication of the source of error in the testing process. Feldt and McKee (1959) pointed out that before statistical

evaluation could be made, the investigator must identify factors contributing to error. Safrit identified two categories of variability: systematic variance and error variance.

Systematic variance is error attributed to fluctuations within the individual performer. This error may be more specifically defined as error due to levels of physical fitness, fatigue, motivation, bodily health, and skill (Feldt & McKee, 1959; Safrit, 1973). Systematic variance may account for individual trial to trial and day to day fluctuations in score. The error is systematic in that it may be predicted given knowledge of the influence of testing factors. The error is not caused by flaws within the measurement process (Safrit, 1973). The investigator may partially control for this error but may not eliminate its effects (Roscoe, 1975).

Error variance is attributed to measurement error. Fluctuations in test scores may be attributed to inconsistencies in equipment, test administration, timing, or scoring. Although these sources of error are not attributed to the performer, they may cause fluctuations in individual performance. Error variance may also reflect the level of objectivity of the test. Instances where one or more individuals subjectively evaluate performance presents the possibility of error due to lack of objectivity. This factor may also occur when one subject or the examiner is allowed to affect the performance of the test subject as in the case of the studies by Netter (1935) and Mushier (1967). This may also be evident in skill tests evaluating passing and catching abilities as reflected in the study by Wilke (1967).

Safrit points out that investigators frequently utilize mechanical throwing devices to ensure objectivity.

Systematic and error variance within testing procedures are frequently isolated by the analysis of variance method of statistical evaluation (Kroll, 1962). Analysis of variance provides an intraclass correlation which may be used to detect relationships between two or more variables. With this procedure, errors attributed to skill level, raters, or equipment may be investigated as influential variables or controlled as blocking variables (Roscoe, 1975). Kroll has pointed out that the intraclass technique "may be expected to be more accurate than interclass correlations derived from the same data and is never expected to be less accurate" (p. 314).

The analysis of variance statistic is a powerful test which is applicable to a wide variety of research problems. However, in order for the procedure to maintain validity, Roscoe states that the research design should adhere to three basic assumptions. First, the test scores must be statistically independent. This may be accomplished by a random selection of subjects or through a random assignment of subjects into experimental groups. Second, the test scores should be selected from a normally distributed population. It is suggested that relatively large samples of equal size be used to ensure a normal distribution. Finally, the test scores should be drawn from populations having the same variance. Although the investigator is unable to determine the homogeniety of variance of the population, selection of samples of equal size has been shown to reflect these assumptions.

Kroll (1962) states that the data examined should not exhibit sequential ordering. This ordering or trend effect is a result of a fluctuation of means between trials which is too large to be caused by measurement error (Safrit, 1973). Trend may be caused by fatigue, boredom, or learning. If the trend effect is present, the assumption of the randomness of scores has been violated. Orthogonal tests may be used to detect trends in the data (Winer, 1971). The effects of trend may be eliminated by the selection of specific scores or trials or by the use of an intraclass correlation formula which has been adjusted for trend (Safrit, 1973).

An effort was made to determine statistical methodology for reliability most applicable to the present study. Lacrosse skill tests prior to 1972 utilized interclass correlation designs. These designs were limited by the number of data groups analyzed and the inability of the statistics to isolate specific error factors. Tests were limited to the comparison of data groups in test-retest and odd-even designs. Barrett, Hodges, Wilke, Lutze, and Hicks utilized the Pearson-product moment method to analyze test-retest designs. Wilke utilized both the test-retest and the odd-even design to determine reliability coefficients for her study. Interclass correlation techniques utilized by these investigators were limited in their ability to account for systematic and error variance within the testing groups. Hopkins (1972) incorporated the intraclass correlation statistic to analyze the results of the Wall Volley test for skilled male lacrosse players. Hopkins analyzed the data by trials and subjects,

thus producing a more accurate measure of reliability (Kroll, 1962). It was determined that an analysis of variance repeated measures design with fixed effects and subjects nested within levels should be used when determining correlation coefficients for the present study (Winer, 1971).

## Validity

A claim for validity of the test was dependent on adherence to the objectives for the test and to the criteria for levels of lacrosse skills. The revised Hodges Rating Scale was used as the criterion measure for the comparison of time test scores. A review of lacrosse skill test literature revealed concerns within the traditional methods of rater established validity. In past studies, failures to achieve desired validity were attributed to the limited time available to observe subjects, disagreement among judges concerning interpretation of criteria, and the complexity of the rating scale itself.

Rating scale. Inconsistencies that could have resulted from interpretation of criteria were minimized by increasing the specificity of the rating scale (Safrit, 1973). The five-point rating scale developed by Hodges was found to be applicable to the evaluation of lacrosse skills. However, it was observed that this scale was limited to global statements describing levels of ability within specific skills. For the purposes of the present study, the rating scale was revised to place the criteria for each discrete skill under the appropriate performance level heading. Specific statements were developed

to apply each skill to the game situation. The original statement: "Cradling - characterized by jerky movements" (Hodges, 1967, p. 58) was appended to include additional criteria: "Frequently drops the ball under pressure." Efforts were made to ensure that the total statement remained applicable to a variety of game situations. The revised rating scale appears in Appendix E.

The greater complexity of the revised rating scale required an extention of the time allotted for the evaluation of subjects beyond that used by Hodges. The rater must be familiar with lacrosse and available to observe subjects in a variety of situations over an extended time period. In view of these criteria, the coach was found to be the only individual qualified to evaluate her players.

Although the utilization of coaches as raters was novel to lacrosse skill testing, this process for obtaining comparisons has been used frequently in literature pertaining to the prediction of player success in various sports. Everett (1952) compared baseball coaches' predictions of their players' success with game statistics from season play. Ellenburg (1970) examined coaches' perceptions of the importance of selected physical abilities as predictors of success in basketball. Talton (1972) investigated coaches' ability to rate their players as successful or unsuccessful when compared with the results of physical and psychological tests and with performance statistics from season play. These investigators confirmed the ability of coaches to predict player success. However, they expressed the need for coaches to be knowledgeable in their sport and to be familiar with

their individual players. Further criteria for accurate prediction included the ability of the rating scale to correspond with the characteristics under evaluation.

Selection of coaches. Varsity intercollegiate coaches from five Virginia colleges were selected as raters for this study. Coaches were asked to rate their own players in an attempt to utilize a more complex rating. Therefore, the rating procedure required that each coach be familiar with the game of lacrosse and be able to observe subjects in a variety of situations over an extended period. In addition, all raters had been coaching at their present college for a minimum of two years. This latter criterion ensured that each coach was familiar with the skills and abilities of her players.

Classification of players. Players were classified into levels of performance in an attempt to support the validity of the test instrument. A revision of Hodges' Rating Scale was used. Rating scales were sent to coaches two weeks prior to the testing date. Each coach was asked to record her players' names and to categorize each player into one of five performance levels. Subjects did not view coaches' ratings prior to performance. Coaches rated players between March 16, 1977, and April 15, 1977.

Statistical methodology for validity. Statistical methods used to compute concurrent validity coefficients in previous attempts at lacrosse skill testing have been limited to the use of the Pearson-product moment method or the Spearman rank order method (rho).

Because the results of this correlation technique are a direct function of sample size, coefficients computed with small sample sizes as in the studies by Netter, Lutze, and Hicks may be misleading (Roscoe, 1975). Furthermore, both methods depend on the conversion of raw data to either z-scores as in the Pearson method or to rankings as in the Spearman method. Both conversions eliminate relevant information necessary for accurate statistical evaluation.

An alternative method was sought for the present study to compute comparisons between sets of ordinal and interval data to retain as much information as possible. The Kendall rank correlation coefficient (tau) was selected based on these criteria. The Kendall tau computed the validity coefficient by "determining the number of discrepancies in a series of paired ranks . . ." (Roscoe, 1975, p. 110). The Kendall tau continued by forming a ratio between this quantity and the number of consistencies which would be present in a perfect correlation. It is noted that in the Kendall tau, like the Spearman rho, the data must be ranked. However, because the Kendall tau is a partial correlation coefficient, the effects of all variables are considered so that much of the information revealed in the original relationships is retained (Roscoe, 1975). The Kendall tau and the Spearman rho were derived from different numerical formulae. Therefore, identical sample data sets analyzed with the Kendall tau and the Spearman rho would reveal coefficients of $r = .82$ and $r = .67$, respectively.

In the present study the ordinal data, coaches' ratings, and the interval data, time scores, were correlated. The resulting tau

coefficient represented the value for concurrent validity. An additional measure of concurrent validity was established through the use of the discriminant analysis statistic. The overall success of the discriminant analysis when classifying subjects into level by mean time scores as compared with coaches' ratings was considered an indicator of concurrent validity.

Construct validity was determined through the use of the analysis of variance and discriminant analysis statistics. A significant F value determined through the analysis of variance statistic was subjected to post hoc comparisons to locate specific differences between level. Evidence of statistically significant differences between levels was used to confirm the claim of construct validity. The discriminant analysis statistic was also used to analyze construct validity. In this statistic the discriminating variable, time, was used to classify subjects into levels. The percentage of correct classifications for each level was then compared with the coaches' classifications (Nie et al., 1975). Since construct validity is determined by the efficacy of a score to show differences in performance of a trait or skill, grouping by discriminant analysis would be an effective procedure.

## Treatment of the Data

Time scores comprised the data for the study. Scores were analyzed by the analysis of variance repeated measures design with fixed effects and subjects nested within levels. The Statistical Analysis System

(SAS) computer program was used to determine the effects of skill level on trial conditions (Barr et al., 1976). Figure 1 illustrates the factorial breakdown for this study. Tests for post hoc comparisons of group means were computed for the data when the analysis of variance procedure indicated that the F test was significant at the .05 level. The post hoc comparisons of group means were used to locate differences for main and interaction effects. The analysis of variance statistic was used to confirm the claim of construct validity when significant differences were found between levels.

Further claim for construct validity was made through the use of the discriminant analysis statistic. The Statistical Package for the Social Sciences (SPSS) computer program was chosen to compute a discriminant analysis on the test data (Nie et al., 1975). The discriminating variable, mean time scores, was used to classify subjects into level groups. Results were recorded as the percentage of subjects correctly classified with this statistic.

Concurrent validity was established through the use of the Kendall rank correlation coefficient (tau). The SAS computer program was used to compute the interclass coefficient of comparison between coaches' rankings and time test scores (Barr et al., 1976). An additional measure of concurrent validity was established by the use of discriminant analysis. Classifying subjects into level by mean time scores and comparing these with coaches' ratings was considered an indicator of concurrent validity. Computer access to the SAS analysis of variance, the SAS Kendall tau, and the SPSS disciminant analysis may be found in Appendix F.

| Trials | 1 | 2 | 3 |
|---|---|---|---|
| $S_1$ Level 1 $S_{19}$ | | | |
| $S_{20}$ Level 2 $S_{38}$ | | | |
| $S_{39}$ Level 3 $S_{57}$ | | | |
| $S_{58}$ Level 4 $S_{76}$ | | | |
| $S_{77}$ Level 5 $S_{95}$ | | | |

Figure 1. Factorial Design

# CHAPTER IV

## DATA ANALYSIS AND DISCUSSION

In the present study the effect of the relationship of skill level to the trial performance of women college lacrosse players was examined. Players were categorized into five ability levels. The results of three trial conditions were examined. Ninety-five subjects were randomly selected and their time scores submitted to statistical evaluation. Time scores were recorded to the nearest tenth of a second. Players' total score for each trial was the time score minus the one second deduction for a successful shot for goal. Experimental data representing players' total scores for each trial was the time score minus the one second deduction for a successful shot for goal. Experimental data representing players' total scores for each trial are presented in Appendix G. The reliability of the test was computed using an analysis of variance repeated measures design with fixed effects and subjects nested within groups (Winer, 1971). Orthogonal tests for trend were computed to confirm the assumption of randomness of scores underlying the analysis of variance statistic (Winer, 1971). The concurrent validity of the test was calculated using the Kendall rank correlation coefficient, tau (Siegel, 1956). The construct validity of the test was determined through the use of the analysis of variance and the discriminate analysis statistics. Post hoc comparisons on analysis of variance results located specific differences

between levels. The discriminant analysis results were used as an additional indicator of construct validity. Numerically high percentages of success were used to confirm the accuracy of the time scores as a classification technique when compared with coaches' ratings (Nie et al., 1975).

## Question One

The purpose of the study was to develop a test to provide an objective measure of selected lacrosse skills performed in combination. The test attempted to discriminate two levels of lacrosse skill. An *F* value of 41.67 indicated that a significant difference existed between levels. The Scheffé test for post hoc comparisons was used to compute the location of significant differences between levels. This test was chosen in order to apply the most stringent criteria to the data relevant to the purposes of the analysis (Winer, 1971). Post hoc comparisons revealed that Level E performance was significantly different from all other levels. Further comparisons revealed that Level D was significantly different from Level A. There were no significant differences between Levels A, B, and C or between Levels B, C, and D. Therefore, of the five ability levels under examination, the test successfully discriminated two levels. Figure 2 shows the relationships between the levels revealed through post hoc comparisons.

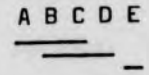


Figure 2. Post Hoc Comparisons Showing Relationships Between Levels for Time Scores

Figure 3 represents a graph of the mean time scores by level. Orthogonal tests noted that a quadratic trend existed over the levels (Winer, 1971). The quadratic trend resulted from the influence of the mean time scores for Level E on the otherwise linear relationships of the mean scores. The mean time scores, analysis of variance results, and the Scheffé test for post hoc comparisons are presented in Table 1.

The Scheffé test for post hoc comparisons revealed that the lacrosse test identified two distinct levels of lacrosse skill, thus establishing construct validity. An estimation of reliability revealed an intraclass coefficient of R = .89 (Ebel, 1951). The formula for this computation may be found in Appendix H.

The validity coefficient was computed using the Kendall rank correlation coefficient, tau. The Kendall tau analyzed the effectiveness of the coaches' ratings comparing subjects' level classification with the mean time scores. The Kendall tau statistic revealed an interclass coefficient of r = .66.

The discriminant analysis technique was utilized to provide additional information concerning the accuracy of the classification system. The discriminant analysis technique computed the discriminant function score for each subject. Because each subject was initially nested within level, the probability of level classification could be predicted. The discriminant analysis analyzed the effectiveness of the time variable when used to classify each subject within level groups as defined by coaches' ratings. In discriminant analysis it may be assumed that, if a large proportion of misclassifications

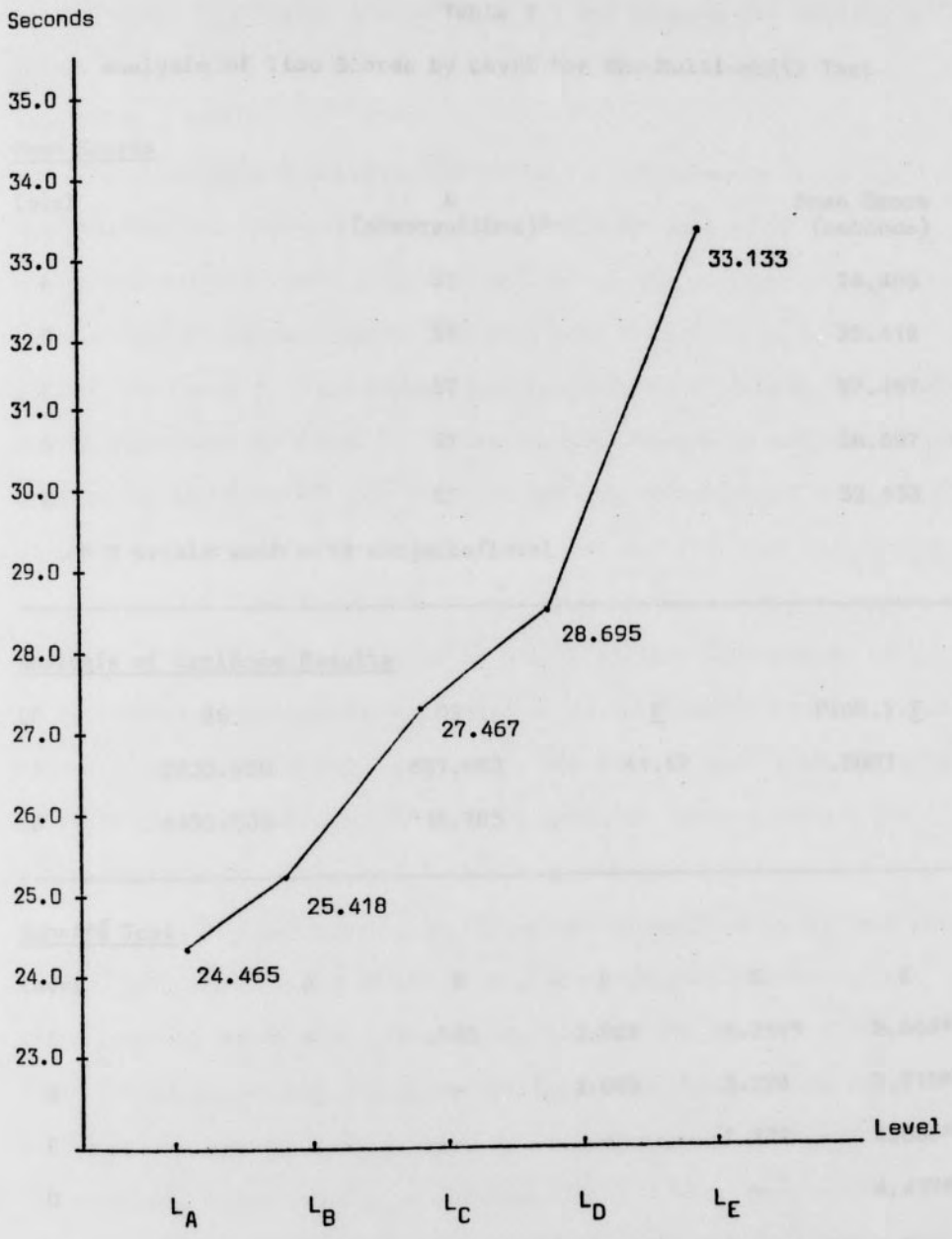


Figure 3. Graph of Mean Time Scores by Level

Table 1

Analysis of Time Scores by Level for the Multi-skill Test

Mean Scores

| Level | N (observations)* | Mean Score (seconds) |
|---|---|---|
| A | 57 | 24.465 |
| B | 57 | 25.418 |
| C | 57 | 27.467 |
| D | 57 | 28.697 |
| E | 57 | 33.133 |

* 3 trials each - 19 subjects/level

---

Analysis of Variance Results

| DF | SS | MS | F | Prob.> F |
|---|---|---|---|---|
| 1 | 2630.650 | 657.663 | 41.67 | .0001 |
| 8 | 1420.505 | 15.783 | | |

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Scheffé Test

| Level | A | B | C | D | E |
|---|---|---|---|---|---|
| A | - | .953 | 3.002 | 4.231* | 8.668* |
| B | | - | 2.049 | 3.278 | 7.715* |
| C | | | - | 1.229 | 5.666* |
| D | | | | - | 4.437* |
| E | | | | | - |

* Significant at .05 level; d> 4.07

occurred, the discriminating variable did not possess the ability to correctly classify subjects as dictated by the accepted criterion (Nie et al., 1975).

The discriminant analysis technique for the present study utilized the time variable to classify correctly 52.7 percent of the subjects within the correct level groups as defined by the coaches' ratings. The accuracy of classification was 63.2 percent for Level A, 42.1 percent for Level B, 31.6 percent for Level C, 53.7 percent for Level D, and 73.7 percent for Level E. These results provide an additional perspective on the Scheffé test for post hoc comparisons used to distinquish significant differences between levels. The Scheffé test isolated the mean of Level E from the means of all other levels. Further complementary information was obtained by noting similar percentages of correct classifications between Level B (42.1 percent), Level C (31.6 percent), and Level D (53.7 percent). The Scheffé test also revealed no significant differences between the means of these levels. The discriminant analysis further revealed that Level A and Level E possessed the highest percentage of correct classifications. Because the subjects were nested within level, each category of the rating scale received equal use. This design avoided the problem cited by Hicks (1971) concerning the under utilization of the extreme categories of the rating scale. This problem was also observed in studies by Lutze (1963), Wilke (1967), and Hodges (1967). From the present study it can be noted that the categories which raters most frequently hesitated to use were those in which coaches' rankings were most accurate

when compared to the time test scores. Therefore, it is concluded that within the limitations of the present study, the nested design contributed to the greater accuracy of player categorization by time scores within Level A and Level E. However, neither the time scores nor the coaches' classifications discriminated significantly between Levels B, C, and D. This may be the result of fluctuations in skill level and performance characteristic of the intermediate level player (Harrow, 1972). Table 2 reveals the percentage of subjects accurately classified by the discriminant analysis technique within each level. It also reveals the location and the extent of the errors within the classification process.

Traditionally the assumption of the concurrent validity of a skill test has been based solely on the comparison of player performance on the skill test with the player performance as evaluated by a panel of experts. In using this procedure, investigators assumed that the experts were knowledgeable of the subject area and consistent within themselves and with each other. The investigators further assumed that the raters received sufficient observation time for each subject and that the rating scale reflected test criteria. In the majority of previous lacrosse studies one or more of these assumptions has been violated, resulting in depressed validity scores. Lutze, Wilke, and Hodges each questioned the ability of their validity coefficients to accurately represent the true validity of their subtests. Therefore, the use of the discriminant analysis to provide an alternate evaluation of the data was not only unique to lacrosse skill testing

Table 2

Discriminant Analysis - Classification Results

| Nested Group | N | Predicted Group Membership | | | | |
|---|---|---|---|---|---|---|
| | | Level A | Level B | Level C | Level D | Level E |
| Level A | 19 | 12<br>63.2% | 4<br>21.1% | 2<br>10.5% | 1<br>5.2% | |
| Level B | 19 | 7<br>36.8% | 8<br>42.1% | 2<br>10.5% | 2<br>10.5% | |
| Level C | 19 | 3<br>15.8% | 4<br>21.1% | 6<br>31.6% | 4<br>21.1% | 2<br>10.5% |
| Level D | 19 | 1<br>5.2% | 1<br>5.2% | 4<br>21.1% | 10<br>52.7% | 3<br>15.8% |
| Level E | 19 | | | | 5<br>26.3% | 14<br>73.7% |
| Total Subjects Classified into Levels by Time Score | | 12<br>23.0% | 17<br>17.9% | 14<br>14.7% | 22<br>23.2% | 19<br>20.0% |
| Total Subjects Classified into Levels by Coaches' Ratings: | | | | | | 50<br>52.7% |

but also essential to the understanding of the results. The frequency of the players classified into each group by the time scores is evident by viewing the percentages of correct classifications by columns instead of by rows (see Table 2). The discriminant analysis of time scores classified 23 players or 24.2 percent into Level A, 17 players or 17.9 percent into Level B, 14 players or 14.7 percent into Level C, 22 players or 23.2 percent into Level D, and 19 players or 20.0 percent into Level E.

The discriminant analysis technique converted the time scores into values which may be used as a comparative measure of player ability. The player who was placed in Level D by coaches ratings and Level B by test classification may be identified and analyzed more carefully to determine the source of the discrepancy. Discrepancies between the two classification results may be traced to 'halo' effects or simply to the hidden ability of the player. More specifically, the present test was designed to measure lacrosse skill. However, coaches frequently analyze the 'whole' player as reflected by the term 'playing ability.' While the limitations of skill tests in measuring playing ability have been noted, coaches may experience difficulty separating lacrosse skill from playing ability (Lawther, 1977). This inconsistency may account for the overall discrepancies between classifications of players by coaches and classifications of players by time scores.

The overall 'accuracy' of the coaches'ratings was compared with the 'accuracy' of time scores. The tau coefficient of $r = .66$ was squared to reveal a coefficient of determination of 43.6 percent (Roscoe, 1975). This coefficient represented the percentage of subjects correctly classified by coaches when compared to time scores. This value can be compared with the value of 52.7 percent representing the percentage of subjects correctly classified by the time scores when compared to coaches' ratings. The overall consistency of these juxtaposed evaluations of the data reflect the consistency of the validity coefficient.

The Kendall tau and the discriminant analysis confirmed the ability of the coaches and the time test scores to classify players. Combining the use of the Kendall tau and the discriminant analysis techniques provided both a rank-order and an interval analysis of the discriminating data. The use of both a non-parametric and a parametric statistic provided unique information, while confirming previously determined relationships. The results indicated that either the test or the revised rating scale may be used to classify players effectively. Thus, the test may be necessary for inexperienced coaches to classify their players into two or more categories, while the revised rating scale may be preferred by experienced coaches to rate their players accurately.

Question Two

The test successfully measured two levels of lacrosse skill without the use of special target or catapult devices. The lacrosse test required the use of eight cones, one standard lacrosse cage, and one stopwatch with the ability to measure time scores to one tenth of a second. The reliability coefficient between levels of $R = .89$ indicated that the test was a reliable measure of lacrosse skills. The concurrent validity coefficient established with the Kendall tau technique was $r = .66$, indicating that the test was a valid measure of lacrosse skills when compared with coaches' ratings. Therefore, the test was able to effectively discriminate two levels of lacrosse skill without the use of special target or catapult devices.

Question Three

The test reliably measured skills when used by a trained examiner who was not a lacrosse expert. Analyses between trials and trial by level were computed to determine the overall reliability of the test. An F value of 11.89 revealed that a significant difference existed between trials. The Newman-Keuls test for post hoc comparisons was used to locate significant differences between trials. This test was chosen in an effort to apply stringent criteria to the data relevant to the purposes of the analysis (Winer, 1971). Post hoc comparisons revealed that differences existed between Trials 1 and 3. Statistically significant differences between Trials 1 and 3 indicated the possibility of a practice effect as reflected over the range of three trials. No significant differences were found between Trials 1 and 2 or Trials 2 and 3. Figure 4 shows the relationships between the trials as revealed through post hoc comparisons. Orthogonal test for trend indicated that no statistically significant trend relationships existed between trials (Winer, 1971). A graph of the mean scores by trial is presented in Figure 5. The mean time scores, analysis of variance, and post hoc comparisons by trial are presented in Table 3.

A nonsignificant F value of 1.23 was found between trials when considering the effects of level. Figure 6 presents a graph of mean time scores trial by level. The mean scores and the results of the analysis of variance are found in Table 4.

1 2 3

Figure 4. Post Hoc Comparisons Showing Relationships Between Trials for Time Scores

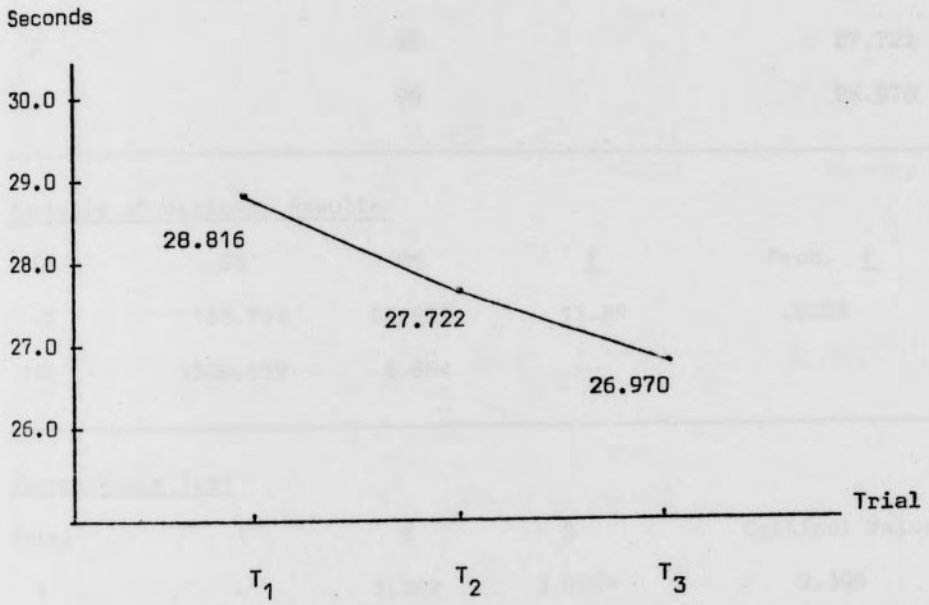


Figure 5. Graph of Mean Time Scores by Trial

Table 3

Analysis of Time Scores by Trial for the Multi-skill Test

Mean Scores

| Trial | N (observations) | Mean Score (seconds) |
|---|---|---|
| 1 | 95 | 28.816 |
| 2 | 95 | 27.722 |
| 3 | 95 | 26.970 |

Analysis of Variance Results

| DF | SS | MS | F | Prob. F |
|---|---|---|---|---|
| 2 | 163.764 | 81.822 | 11.89 | .0001 |
| 180 | 1239.139 | 6.884 | | |

Newman-Keuls Test

| Trial | 1 | 2 | 3 | Critical Value |
|---|---|---|---|---|
| 1 | - | 1.267 | 3.078* | 2.396 |
| 2 | | - | .156 | 2.154 |

* Significant at .05 level

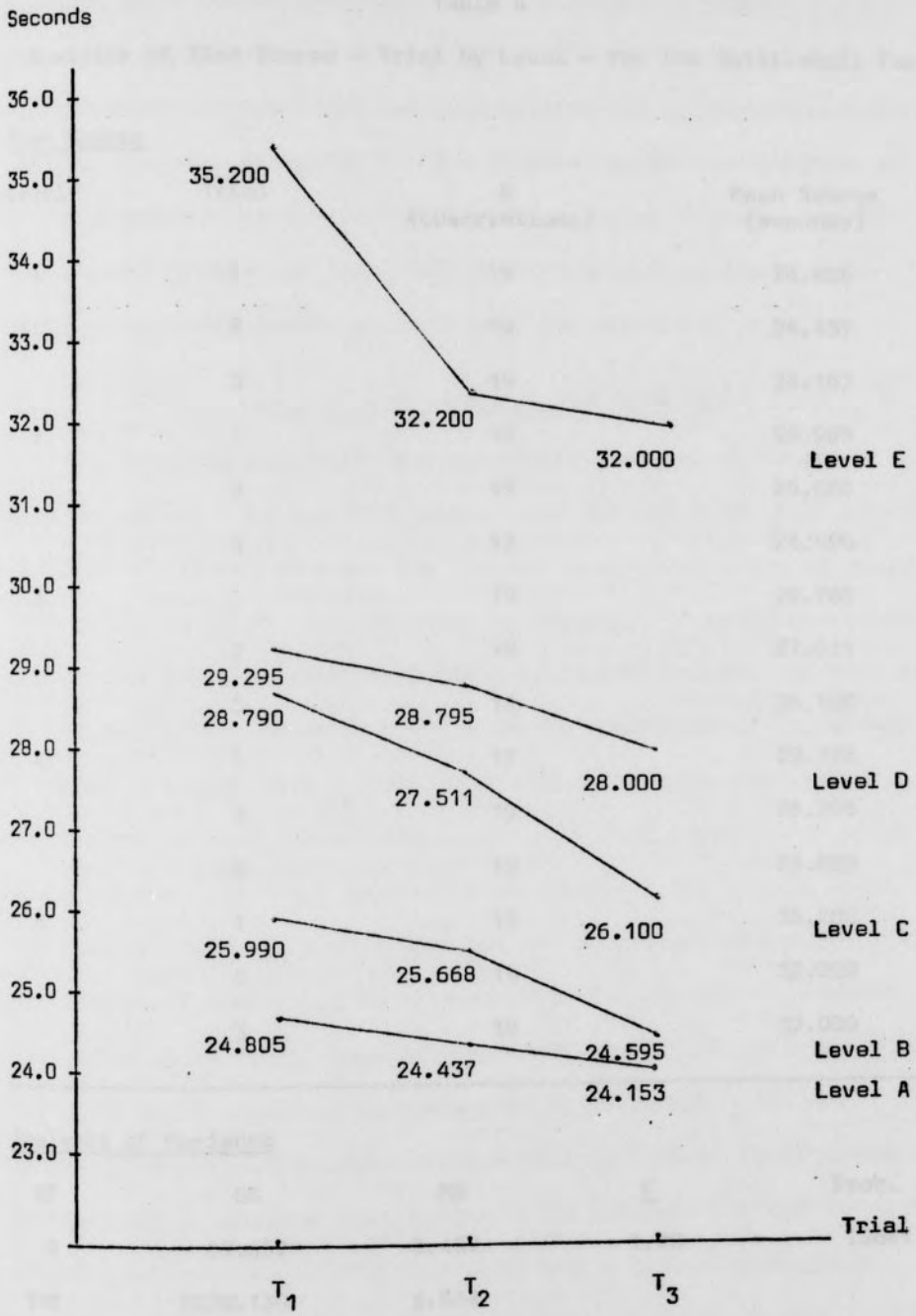


Figure 6. Graph of Mean Time Scores - Trial by Level

Table 4

Analysis of Time Scores - Trial by Level - for the Multi-skill Test

Mean Scores

| Level | Trial | N (observations) | Mean Scores (seconds) |
|---|---|---|---|
| 1 | 1 | 19 | 24.805 |
| | 2 | 19 | 24.437 |
| | 3 | 19 | 24.153 |
| 2 | 1 | 19 | 25.989 |
| | 2 | 19 | 25.668 |
| | 3 | 19 | 24.595 |
| 3 | 1 | 19 | 28.789 |
| | 2 | 19 | 27.511 |
| | 3 | 19 | 26.100 |
| 4 | 1 | 19 | 29.295 |
| | 2 | 19 | 28.795 |
| | 3 | 19 | 28.000 |
| 5 | 1 | 19 | 35.200 |
| | 2 | 19 | 32.200 |
| | 3 | 19 | 32.000 |

Analysis of Variance

| DF | SS | MS | F | Prob. F |
|---|---|---|---|---|
| 8 | 67.657 | 8.457 | 1.23 | .2847 |
| 180 | 1239.139 | 6.844 | | |

The Newman-Keuls test for post hoc comparisons between trials revealed a significant difference between Trial 1 and Trial 3. An estimation of between trial reliability produced an intraclass coefficient of R = .78 (Ebel, 1951). The formula for this computation may be found in Appendix H. The interaction of trial by level was not significant, indicating the stability of the test to discriminate reliably two skill levels regardless of the effects of trial.

## Practical Significance of Findings

The test was unable to discriminate five different levels of lacrosse skill. One factor which may have accounted for this lack of statistical significance was the limited amount of structured practice time available to each player prior to testing. Although statistical comparisons between trials revealed a difference between Trials 1 and 3, the steady decline in mean trial scores regardless of the effects of level indicated that a practice effect influenced trial scores. The decline in test scores indicated a practical significance which suggested the need for a revision when utilizing the present test. The test will provide a more accurate and consistent measure of player performance if the player is allowed unlimited structured practice time prior to testing. This provision may also aid in the clarification of skill level within the middle three groups which are presently indistinquishable. Further observations of trial scores within Level E revealed that the beginning players achieved top performance by Trial 2. Within the three trials under observation, beginning performers were unable to utilize intrinsic sensory feedback

to further adjust their performance to the specific test situation (Lawther, 1977). Beginning performers may also have been limited by an insufficient quantity of appropriate past experiences (Harrow, 1972). Specific tasks which required the player to pick up a stationary ball and turn immediately to the right or to the left presented highly structured tasks which may be avoided by technically weak players within the game situation.

A trained examiner who is not a lacrosse expert may successfully utilize the test to objectively discriminate two levels of lacrosse skill. The test represents an objective measure because subjects were not affected by a starting signal, skill criteria or the performance or skill level of other subjects. In addition, the duties of the examiner were limited to the objective evaluation of test performance. Specific examiner duties included starting the stopwatch as the subject touched the stationary ball, recording the success or failure of the goal attempt, and stopping the stopwatch as the ball crossed the 'finish line.' The examiner was not required to make any subjective judgments regarding the technique or proper execution of specific lacrosse skills.

Relevance, Objectivity, and Discriminating Power of the Test

Items were selected and combined on the basis of relevance, objectivity, and discriminating power. A review of lacrosse skill test literature revealed four attempts to combine individual subtests into batteries. Lutze, Wilke, Hodges, and Hicks were generally unsuccessful in their attempts to develop valid batteries to

measure lacrosse playing ability. Subtests were frequently time consuming and unrepresentative of the game situation. Furthermore, subtests required complex equipment alien to the teaching/coaching situation. Exceptions, however, were the subtests which measured skills in combination. The pick up, pivot, and dodge tests developed by Lutze, Hodges, and Wilke provided reliable, game-like tests which did not require complex equipment. This 'multi-skill' format was later revised by Hicks for use as an achievement test for beginning players.

The present study investigated the development of a complex multi-skill test as a measure of the open skill of lacrosse. The task-oriented design of the test provided a decision making atmosphere utilizing lacrosse skills which could be measured objectively. The present study provided a test which was relevant to the lacrosse teaching/coaching situation with respect to skills selected and to equipment and testing time required. A claim for additional relevance is made in relation to the application of the test to lacrosse instruction. The test provides a structured drill situation combining five skills in a game-like situation. The competitive characteristics of lacrosse may be further emphasized by placing defense players at strategic locations, requiring even greater ball and body control. It is concluded that the multi-skill format provides a more relevant setting for the evaluation of lacrosse skills than the battery design as utilized in previous lacrosse studies.

In the majority of studies reviewed, the investigator recognized the importance of objectivity to the skill testing situation. However,

studies by Netter (1935) and Mushier (1967) compromised the criterion of objectivity in favor of tests which were more practical or instructional within their specific environments. The present investigator selected objectivity as a primary criterion. The testing situation was controlled to avoid the subjective influence of the examiner. In addition, subjects were not influenced by the starting signal, technique criteria, or the performance or ability level of other subjects. It is asserted that the present study meets the criterion of objectivity at a comparable level with other lacrosse skill test studies with the exception of studies by Netter and Mushier.

A claim for discriminating power is made based on the process of skill selection and combination. In addition, the task-oriented multi-skill format required players to adapt their skills to the testing situation. The one second deduction for a successful shot on goal was influential in discriminating skill level. Of the fifty-seven observations recorded for each skill level , 31 or 54.4 percent included successful goal attempts at Level A, 35 or 61.4 percent at Level B, 21 or 36.8 percent at Level C, 28 or 49.1 percent at Level D, and 28 or 49.1 percent at Level E. The quantity of successful deductions at each level influenced the overall level mean as reflected in the analysis of variance results.

This deduction method, first introduced in the skill test literature by McGowan (1965) provided an objective method for discriminating skill level. Although previous lacrosse studies have been developed for a variety of skill levels, these investigators (Barrett, 1959;

McGowan, 1965; Mushier, 1967; and Hodges, 1967) did not choose to utilize their tests to discriminate skill level. The present test discriminated two levels of lacrosse skill as defined by coaches' ratings. The test was not considered to be effective in distinguishing the three middle skill levels as defined by the coaches' ratings or the time test scores.

A claim is made for the relevance, objectivity, and discriminating power of the present test based on the conservative and comprehensive nature of the statistics selected. When comparing the present test with previous skill tests in lacrosse, it is asserted that the present test is the most reliable and valid measure of lacrosse skill developed to date.

The between level and between trial coefficients of reliability of $R = .89$ and $R = .78$, respectively, and the validity coefficient of $r = .66$ established the test as an accurate discriminator of two levels of lacrosse skill. The investigator suggests that the test be used to compliment or confirm present information or to provide an objective measure of lacrosse skill. It is suggested that the validity and reliability coefficients are too low to allow the test to be used as the sole indicator of lacrosse skill. In addition, while the test is an accurate discriminator of lacrosse skill of beginning and advanced players, the ability of the time test to discriminate intermediate skill levels is questionable. The test is submitted as a useful instructional tool to be utilized in formative evaluations. The multi-skill format incorporating the task oriented concept was

found to be a reliable and valid measure of the open skills of women's lacrosse as investigated within the limitations of the present study.

# CHAPTER V

# SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

## Summary

The purpose of this study was to examine the development of a test to provide an objective measure of selected lacrosse skills. The items for the test were chosen on the basis of relevance, objectivity, and discriminating power. Lacrosse skills meeting these criteria included dodging, picking up, pivoting, throwing, and shooting. In addition, speed and agility were incorporated as important characteristics of lacrosse. Skills were combined in a multi-skill format in an attempt to approach the game situation and to decrease the time required for testing. The test required skill and knowledge of lacrosse technique and the flexibility to adapt skills to new situations. Test directions did not require specific skills, but encouraged the completion of the total task as quickly and as skillfully as possible.

One hundred and five players from five Virginia colleges served as subjects for the study. Varsity lacrosse coaches from each college rated their players into five levels using a revision of the Hodges' Rating Scale. Coaches rated players two weeks prior to testing.

Ninety-five subjects were randomly selected from the population of players tested and their test scores submitted to statistical evaluation. Time scores comprised the data for the study. Scores were analyzed by the analysis of variance repeated measures design with

fixed effects and subjects nested within level. The Statistical Analysis System computer program was utilized to determine the effects of the relationship of skill level to the trial performance of test subjects. Post hoc comparisons of group means were computed for the data when the analysis of variance procedure indicated that the F test was significant at the .05 level. The coefficient of reliability between levels and between trials was R = .89 and R = .78, respectively. The Statistical Analysis System computer program was used to compute a discriminant analysis of the test data. The discriminating variable, time, was used to classify subjects into level groups. The discriminant analysis classified correctly 52.7 percent of the test subjects as defined by coaches' ratings.

The test was found to discriminate two levels of lacrosse skill without the use of complex equipment when used by a trained examiner who was not a lacrosse expert. The revised Hodges' Rating Scale was also found to be an effective rating devise when used by experienced lacrosse coaches to rate their own players. Within the limitations of the present study, the multi-skill format was found to provide a more relevant setting for the evaluation of lacrosse skills than did the battery design as utilized by previous lacrosse investigators.

## Conclusions

### Question One

Is the test a valid measure of lacrosse skill?

a. Does the test discriminate two levels of lacrosse skill?

b. Can concurrent validity be established?

A claim for construct validity was made based on the success of the lacrosse test to discriminate two skill levels. The Scheffé test for post hoc comparisons was used to locate significant differences between level scores. The Scheffé test revealed statistically significant differences between Level A and Level E, confirming the existence of two levels of lacrosse skill. The discriminant analysis used the discriminating variable, mean time scores, to categorize players by level. The time variable accurately classified 63.2 percent in Level A and 73.7 percent in Level E when compared with coaches' ratings. The success of the time variable when categorizing players by level supports the construct validity of the test.

The concurrent validity of the test was established through the use of the Kendall tau statistic to compute the interclass correlation coefficient between coaches' ratings and mean time scores. The coefficient of $r = .66$ confirmed the claim of concurrent validity. An additional claim for concurrent validity was based on the overall success of the discriminate analysis. Based on prior probabilities of 20 percent, the discriminate analysis used mean time scores to accurately classify 52.7 percent of the subjects when compared to coaches' ratings. This overall percentage further substantiates a claim for concurrent validity.

Question Two

Does the test measure levels of lacrosse skill without the use of special target or catapult devices?

The lacrosse test required the use of eight cones, one standard lacrosse cage, and one stopwatch with ability to measure scores to a tenth of a second. The intraclass coefficients of between level and between trial reliability were R = .89 and R = .78, respectively. The concurrent validity coefficient established with the Kendall tau statistic was r = .66, indicating that the test was a valid measure of lacrosse skill when compared with coaches' ratings. Therefore, the test was able to effectively discriminate two levels of lacrosse skill without the use of special target or catapult devices.

Question Three

Does the test reliaby measure lacrosse skills when used by a trained examiner who is not a lacrosse expert?

The lacrosse test did not require subjective judgments from the examiner. The coefficients of between level and between trial reliability were R = .89 and R = .78, respectively. A nonsignificant F value of 1.23 was found between trials when considering the effects of level, indicating the consistency of performance within level regardless of the effects of trials. Therefore, the test is submitted as a reliable measure of lacrosse skills when used by a trained examiner who is not a lacrosse expert.

Additional Conclusions

Additional conclusions seem justified within the limitations of the present study based on the coefficients of reliability and validity and the percentage of accurate classifications established through the

discriminant analysis. First, the task oriented test is an effective tool for the measurement of the open skill sport of lacrosse. Second, the multi-skill format provides a more relevant setting for the evaluation of lacrosse skills than did the battery design as utilized by previous investigators. Third, the revised Hodges' Rating Scale is valid when used by experienced coaches to rate their own players. Finally, the timed test may be utilized as an effective instructional tool within the teaching/coaching situation.

## Recommendations

The investigation led to the following recommendations for future study:

1. Investigate the effects of unlimited structured practice to avoid the effects of practice on trial scores.

2. Investigate the utilization of the multi-skill approach for other sports involving open skills to decrease testing time and to simulate a game-like situation.

3. Investigate the utilization of a task oriented test within other sports involving open skills to allow subjects to select to perform skills which fit their unique abilities.

4. Investigate additional revisions of the Hodges' Rating Scale to increase its power to evaluate lacrosse skills by focusing on the skill itself, with minimal reference to playing ability.

5. Investigate the external validity of the test when applied to male and female junior and senior high school players and to male college players.

# BIBLIOGRAPHY

# BIBLIOGRAPHY

American Psychological Association et al. Standards for educational and psychological tests and manuals. Washington, D.C.: Author, 1966.

Barr, A. J., Goodnight, J. H., Sall, J. H., & Helwig, J. T. A user's guide to SAS. Raleigh, N.C.: SAS Institute, Inc., 1976.

Barrett, K. R. A lacrosse test for general ability. Unpublished study, Bouvé-Boston School, 1959.

Barrow, H. M., & McGee, R. A practical approach to measurement in physical education. Philadelphia: Lea & Febiger, 1971.

Bixler, A. S. Skill tips. In Field hockey-Lacrosse guide. Washington, D.C.: Division for Girls and Women's Sports, American Association for Health, Physical Education and Recreation, June 1972 - June 1974.

Bloom, B. S., Hastings, J. T., & Madaus, G. F. Handbook on formative and summative evaluation of student learning. New York: McGraw-Hill Book Company, 1971.

Boyd, M. Lacrosse playing and coaching. New York: A. S. Barnes and Company, 1959.

Conklin, M. W. Teaching the fundamentals of lacrosse. In Field hockey-Lacrosse guide. Washington, D.C.: Division for Girls and Women's Sports, American Association for Health, Physical Education and Recreation, September 1958 - September 1960.

Cratty, B. J. Psychology in contemporary sport: Guidelines for coaches and athletes. Englewood Cliffs, N. J.: Prentice-Hall, 1973.

Delano, A. L. Lacrosse for girls and women. Dubuque, Iowa: Wm. C. Brown, Company, 1970.

Dietz, D., & Beryl, F. Hockey knowledge test for girls. Journal of Health, Physical Education and Recreation, 1940, 11, 366-387.

Ebel, R. L. Estimation of reliability of ratings. Psychometrika, 1951, 16, 407-427.

Ebel, R. L., & Hill, R. E., Jr. Development and application of tests of educational achievement. Review of Educational Research, 1959, 29, 42-56.

Ellenburg, J. K. The prediction value of selected physical variables in determining competitive performance in high school basketball. Unpublished doctoral dissertation, University of Alabama, 1970.

Everett, P. W. The prediction of basketball ability. Research Quarterly, 1952, 23, 15-19.

Feldt, L. S., & McKee, M. S. Estimation of reliability of skill tests. Research Quarterly, 1958, 29, 279-293.

Fitts, P. M., & Posner, M. I. Human performance. Belmont, Calif.: Brooks/Cole Publishing Company, 1967.

Harrow, A. J. A taxonomy of the psychomotor domain. New York: D. McKay Company, 1972.

Hebb, D. O. The organization of behavior. New York: Science Editions, 1961.

Hicks, N. L. An achievement test battery in beginning lacrosse for college women. Unpublished doctoral dissertation, University of Iowa, 1971.

Hodges, C. V. Construction of an objective knowledge test and skills test in lacrosse for college women. Unpublished master's thesis, University of North Carolina at Greensboro, 1967.

Hopkins, J. E. The development of a wall volley test for skilled male lacrosse players. Unpublished master's thesis, Springfield College, 1973.

Knapp, B. Skill in sport. London: Routledge and Kegan Paul, 1963.

Kosstrin, J. Z. Lacrosse skills: Clues to a faster safer game. Woman Coach, January - February 1976, 2, 6-7.

Kroll, W. A note on the coefficient of intraclass correlation as an estimate of reliability. Research Quarterly, 1962, 33, 313-316.

Lawther, J. D. The learning and performance of physical skills. Englewood Cliffs, N. J.: Prentice-Hall, 1977.

Lewis, B. J. Play lacrosse the easy way. London: Candium Press, 1970.

Ley, K. L. Constructing objective test items to measure high levels of achievement in selected physical education activities. Unpublished doctoral dissertation, State University of Iowa, 1960.

Lutze, M. C. An achievement test in beginning lacrosse for college women. Unpublished master's thesis, University of Iowa, 1963.

Mackey, J. Stickwork for beginners. In Field hockey-Lacrosse guide. Washington, D.C.: Division for Girls and Women's Sports, American Association for Health, Physical Education and Recreation, September 1950 - September 1952.

McGowan, N. A skill test for the overarm pass. In Crosse Checks, 1965.

Mushier, C. Top hand for top notch lacrosse. In Crosse Checks.

Mushier, C. (Dir.). Lacrosse skill test instruction manual. National Sports Skill Testing Project, American Association for Health, Physical Education and Recreation. Unpublished manual, 1967.

Netter, L. The testing of fundamental skills in lacrosse. Unpublished master's thesis, Springfield College, 1935.

Newbold, M. O., & Lockley, K. Lacrosse for clubs and schools. London: Macaire, Mould and Company, Ltd., 1934.

Nie, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., & Bent, D. H. Statistical package for the social sciences. New York: McGraw-Hill, 1975.

Phillips, M. R. Techniques of lacrosse. In Field hockey-lacrosse guide. Washington, D.C.: Division for Girls and Women's Sports, American Association for Health, Physical Education and Recreation, August 1960 - August 1962.

Poindexter, H. B. W., & Mushier, C. Coaching competitive team sports for women. Philadelphia: W. B. Saunders Company, 1973.

Rayfield, M. W. The effect of field positioning on side arm shooting accuracy in lacrosse. Unpublished master's thesis, Springfield College, 1972.

Reeson, J. Know the game - Lacrosse. London: E. T. Publishing Company, 1964.

Roscoe, J. T. Fundamental research statistics for the behavioral sciences. New York: Holt Rinehart and Winston, Inc., 1975.

Safrit, M. J. Evaluation in physical education: Assessing motor behavior. Englewood Cliffs, N. J.: Prentice-Hall, 1973.

Siegel, S. Nonparametric statistics for the behavioral sciences. New York: McGraw-Hill Book Company, 1956.

Stennings, M. A few elementary thoughts on teaching beginners. In Field hockey-Lacrosse guide. Washington, D.C.: Division for Girls and Women's Sports, American Association for Health, Physical Education and Recreation, September 1952 - September 1954.

Talton, B. J. An investigation of selected physical and psychological assessments as predictors of successful high school football performers. Unpublished doctoral dissertation, Northwestern State University of Louisiana, 1972.

Waglow, I. F., & Moore, A. A lacrosse skill test. Athletic Journal, 1954, 35, 43-44.

Wilke, B. J. Achievement tests for selected lacrosse skills of college women. Unpublished master's thesis, University of North Carolina at Greensboro, 1967.

Winer, B. J. Statistical principles in experimental design. New York: McGraw-Hill Book Company, 1971.

# APPENDIX A

## LACROSSE TECHNIQUE

Table 5

Summary of Lacrosse Technique Recommended in Beginning Skill Literature

| Skill | Newbold & Lockley (1934) | Mackey (1950) | Stennings (1952) | Conklin (1952) | Boyd (1959) | Reeson (1964) | Mushier (1965) | Phillips (1969) | Delano (1970) | Lewis (1970) | Bixler (1972) | Poindexter & Mushier (1973) | Kosstrin (1976) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grip | * | * | * | * | * | * | | * | * | * | * | | |
| Cradle | * | * | * | * | * | * | * | * | * | * | * | * | * |
| Catch | * | * | * | * | * | * | | * | * | * | * | * | * |
| Pass | * | | * | | * | * | * | * | * | * | | * | * |
| Pick-up | * | * | * | * | * | * | | * | * | * | | * | * |
| Body Checking | * | * | * | * | * | * | * | * | * | * | * | * | * |
| Crosse Checking | | * | | | * | * | | * | * | * | * | * | * |
| Shooting | * | * | * | | * | * | * | * | * | * | * | * | |
| Dodging | * | * | * | | * | * | * | | * | * | * | * | |
| Pivoting | | * | | | * | * | * | | * | * | * | | * |
| Cutting | | | | | * | * | | | * | * | | | * |

# APPENDIX B

## LACROSSE SKILL TESTING

Table 6

Skills and Equipment Required for Lacrosse Skill Testing

| Investigator | catching | cradling | dodging | passing | picking up | pivoting | shooting | throwing | weaving | Equipment |
|---|---|---|---|---|---|---|---|---|---|---|
| Netter (1935) | * | | | * | | | * | | | goal cage |
| Waglow and Moore (1954) | | * | * | | * | | * | * | * | 3 standards<br>wall target<br>goal cage |
| Barrett (1959) | * | * | | | | | | * | | wall surface |
| Lutze (1963) | * | | * | | * | * | * | * | | wall target<br>wall surface<br>3 standards |
| McGowan (1965) | | | | * | | | | | | wall target |
| Wilke (1967) | * | | * | * | * | | | | | wall target<br>catapult<br>3 standards |
| Mushier (1967) | * | * | * | | * | * | * | * | | wall target<br>rope<br>goal cage<br>wall surface<br>5 standards |
| Hodges (1967) | * | * | * | * | * | * | * | | | wall surface<br>3 standards<br>goal cage/ target |
| Hicks (1971) | * | * | * | | * | | * | * | | wall surface<br>1 standard<br>goal cage/ target |
| Rayfield (1972) | | | | | | | * | | | goal cage/ target |
| Hopkins (1973) | * | * | | | | | | * | | wall surface |

Table 7

Summary of Research Focusing on Lacrosse Skill Testing

| Investigator | Subtests: Catching | Dodging | Passing | Pick up, Pivot, and Dodge | Scoop and Weave | Shooting | Throwing | Wall Volley | Subjects: N | Sex | Skill Level | Statistical Evaluation | Validation - Rating Scale |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Netter (1935) | * | | * | | | * | | | 37 | M | Skilled | Yes | No |
| Waglow and Moore (1954) | | * | | | * | * | * | | ? | M | Beginner | No | No |
| Barrett (1959) | | | | | | | | * | 55 | F | All | Yes | 6-point |
| Lutze (1963) | | | | * | | * | | * | 54 | F | Beginner | Yes | 5-point |
| McGowan (1965) | | | * | | | | | | ? | F | All | No | No |
| Wilke (1967) | * | | * | * | | | | | 143 | F | Beginner | Yes | 5-point |
| Mushier (1967) | * | * | | | | * | * | * | ? | F | All | No | No |
| Hodges (1967) | | | | * | | * | | * | 135 | F | All | Yes | 5-point |
| Hicks (1971) | | * | * | * | | | * | * | 45 | F | Beginner | Yes | 5-point |
| Rayfield (1972) | | | | | | * | | | 16 | M | Skilled | Yes | No |
| Hopkins (1973) | | | | | | | | * | 39 | M | Skilled | Yes | 5-point |

Table 8

Summary of Statistical Evaluations for Lacrosse Skill Testing

| Investigator | N | Statistic | Results | Statistic | Results |
|---|---|---|---|---|---|
| Netter (1935) | 37 | Pearson-product (test-retest) | Passing r=.93-r=.91<br>Shooting r=.91-r=.79<br>Catching r=.97-r=.86 | Pearson-product (w/seasonal statistics) | Passing r=.66<br>Shooting r=.57<br>Catching r=.60 |
| Barrett (1959) | 55 | Kuder-Richardson (interjudge)<br>Pearson-product (test-retest) | r=.906<br>r=.86 | Spearman rho (w/6 pt. rating scale) | r=.71 |
| Lutze (1963) | 54 | Pearson-product (interjudge)<br>Subtests stepped up by Spearman-Brown | r=.84-r=.75<br>Shooting r=.79-r=.77<br>Pass and Catch r=.88<br>Pick up r=.82 | Pearson-product (w/5 pt. rating scale) | Shooting r=.28-r=.11<br>Pass and Catch r=.57<br>Pick up r=.20 |
| Wilke (1967) | 143 | Pearson-product (test-retest, odd even, stepped up by Spearman-Brown) | Passing r=.24, r=.47, r=.78<br>Catching r=.46, r=.54, r=.83<br>Pick up (test-retest) r=.62 | Pearson-product (w/5 pt. rating scale) | Passing r=.17<br>Catching r=.35<br>Pick up r=.40 |

Table 8

Summary of Statistical Evaluations for Lacrosse Skill Testing
(continued)

| Investigator | N | Statistic | Results | Statistic | Results |
|---|---|---|---|---|---|
| Hodges (1967) | 135 | Pearson-product (test-retest) | Wall Volley r=.85<br>Pick up r=.83<br>Shooting not reported | Pearson-product (w/5 pt. rating scale) | Wall Volley r=.40<br>Pick up r=.47<br>Shooting r=.17 |
| Hicks (1971) | 45 | Pearson-product (interjudge)<br>Analysis of Variance (interjudge)<br>Pearson-product (odd even)<br>Pearson-product (test-retest) | r=.58<br>R=.71<br>r=.95-r=.26 (range-5 subtests)<br>r=.89-r=.01 (range-5 subtests) | Pearson-product (w/5 pt. rating scale) | r=.66-r=.15 (range-5 subtests) |
| Rayfield (1972) | 16 | Wilcoxen t | 10 yds.-t values 6,15,6<br>15 yds.-t values 25,21,15 | Not reported | |
| Hopkins (1973 | 39 | Analysis of Variance | R=.97 | Spearman rho | r=.65 |

# APPENDIX C

## PILOT STUDY: STATISTICAL ANALYSIS

Table 9

Pilot Study - Raw Data

| N | Level | Trial 1 | Trial 2 | Trial 3 | Mean Score |
|---|---|---|---|---|---|
| 1 | D | 44.0* | 41.8* | 38.9* | 41.6 |
| 2 | D | 37.7* | 33.7* | 37.7* | 36.4 |
| 3 | D | 39.4 | 37.6* | 31.5* | 36.2 |
| 4 | D | 34.2 | 43.0* | 37.5* | 38.2 |
| 5 | D | 36.9 | 33.9* | 34.6 | 35.1 |
| 6 | D | 34.3* | 37.0* | 38.5* | 36.6 |
| 7 | D | 33.6* | 37.2* | 33.2* | 34.7 |
| 8 | D | 37.2* | 28.3* | 31.2* | 32.2 |
| 9 | D | 35.4* | 32.1 | 35.0 | 34.2 |
| 10 | E | 46.5 | 40.5* | 39.0* | 42.0 |
| 11 | E | 51.0 | 59.4* | 47.4* | 52.6 |
| 12 | E | 36.1 | 40.0 | 36.3* | 37.5 |
| 13 | E | 54.5* | 39.0* | 35.5* | 43.0 |
| 14 | E | 39.3* | 37.6* | 41.4* | 39.4 |
| 15 | E | 48.3* | 40.2* | 40.6* | 43.0 |
| 16 | E | 32.3* | 29.6* | 30.9* | 30.9 |
| 17 | E | 31.5* | 29.4* | 31.9* | 30.9 |
| 18 | E | 37.5 | 43.0 | 40.5* | 40.3 |

* 1 second deduction - successful shot on goal

Table 10

Analysis of Time Scores by Level for Pilot Study

Mean Scores

| Level | N | Mean Score |
|---|---|---|
| 1 | 9 | 36.126 |
| 2 | 9 | 39.970 |

Analysis of Variance Results

| DF | SS | MS | F | Prob F |
|---|---|---|---|---|
| 1 | 199.527 | 199.527 | 2.60 | .1261 |
| 16 | 1225.935 | 76.621 | | |

Table 11

Analysis of Time Scores by Trial for Pilot Study

Mean Scores

| Trial | N | Mean Score |
|---|---|---|
| 1 | 18 | 39.428 |
| 2 | 18 | 37.961 |
| 3 | 18 | 36.756 |

Analysis of Variance Results

| DF | SS | MS | F | Prob F |
|---|---|---|---|---|
| 2 | 64.472 | 32.236 | 2.12 | .1370 |
| 32 | 487.379 | 15.231 | | |

Table 12

Analysis of Time Scores - Trial by Level - for Pilot Study

Mean Scores

| Level | Trial | N | Mean Score |
|---|---|---|---|
| 1 | 1 | 9 | 36.967 |
| 1 | 2 | 9 | 36.067 |
| 1 | 3 | 9 | 35.344 |
| 2 | 1 | 9 | 41.889 |
| 2 | 2 | 9 | 39.856 |
| 2 | 3 | 9 | 38.167 |

---

Analysis of Variance Results

| DF | SS | MS | F | Prob F |
|---|---|---|---|---|
| 2 | 9.943 | 4.972 | .033 | .7239 |
| 32 | 487.379 | 15.231 | | |

Table 13

Pilot Study: Discriminant Analysis - Classification Results

| Nested Group | | Predicted Group Membership | |
|---|---|---|---|
| Level | N | Level D | Level E |
| D | 9 | 7<br>77.8% | 2<br>22.2% |
| E | 9 | 3<br>33.3% | 6<br>66.6% |
| Total Subjects Classified Into Levels by Time Score | | 10<br>55.6% | 8<br>44.4% |

Total Subjects Classified Into Levels by Examiner's Ratings: 13
72.25%

# APPENDIX D

## ENNIS LACROSSE TEST

# ENNIS LACROSSE TEST

## Instructions for Subjects

A. Explanation occurs simultaneously with demonstration.

1. Begin at start/finish line without ball.
2. Run forward to pick up a stationary ball. Time begins as you touch the ball.
3. Turn to your left, around cone 1. Run to the right of cone 2, to the left of cone 3, and to the right of cone 4.
4. Once past cone 4 continue running, toss and catch the ball twice above your head. The examiner must be able to see the ball above your head for each toss. If the ball is not above your head, the examiner will call REPEAT.
5. After tossing and catching the ball twice, shoot for goal. There is no penalty if you miss, but if you are successful, one second will be deducted from your time. You may shoot from anywhere; there is no restraining line.
6. Without the ball, run goal side of cone 5; turn and run backwards to cone 6; and then forward to pick up a ball beside cone 7.
7. Run around cone 7 and throw the ball beyond cone 8. You may throw from anywhere; there is no restraining line. The ball may bounce. If the ball stops before crossing the line, you must use your stick to propel it across. Time will be recorded as the ball crosses the line.

ENNIS LACROSSE TEST

Instructions for Subjects
(continued)

B. Group of eight subjects follows examiner through complete test. Examiner repeats word cues for each task.

C. Explanation

There are many movement and skill short cuts which may be used to cut seconds from your time. This time as you go through the test try to discover ways to move as quickly and skillfully as possible.

D. Group of eight subjects completes second practice trial. Examiner repeats word cues when necessary.

E. Ball Placement

In order to make the test run smoothly, one person should stand behind the goal to collect the shot on goal and throw it to a second person standing beside cone 7. This person will place the ball beside cone 7 as it is positioned now. A third person will stand behind cone 8 to collect the long throw. She should be sure the ball is across the line before it is caught. This person then passes the ball to a fourth person standing near cone 1. This person will place the ball beside cone 1 as it is positioned now. Players can begin the test as rapidly as the ball can be positioned. In addition, three people should stand on cones 2, 3, and 4. Stand with one foot on each side of the cone to allow players to run as close to the cone as possible.

F. Examiner assigns testing order.

# ENNIS LACROSSE TEST

## Instructions for Examiner

A. Allow subjects to begin when ready.

B. Begin time when subject touches stationary ball even if pick-up is unsuccessful.

C. Observe that tosses are above subject's head. If not - call REPEAT. Subject should repeat only unsuccessful tosses.

D. Record success of shot on goal.

E. Backwards running - observe if subject's back is square with start/finish line. If not call BACKWARDS. No penalty is given.

F. Move opposite cone 8. If throw is unsuccessful, encourage player to propel ball over line. Record time as the ball crosses the line.

G. Time is recorded to the nearest tenth of a second. Score is time for trials minus a one-second deduction for successful goal. Final score is sum of three trials.

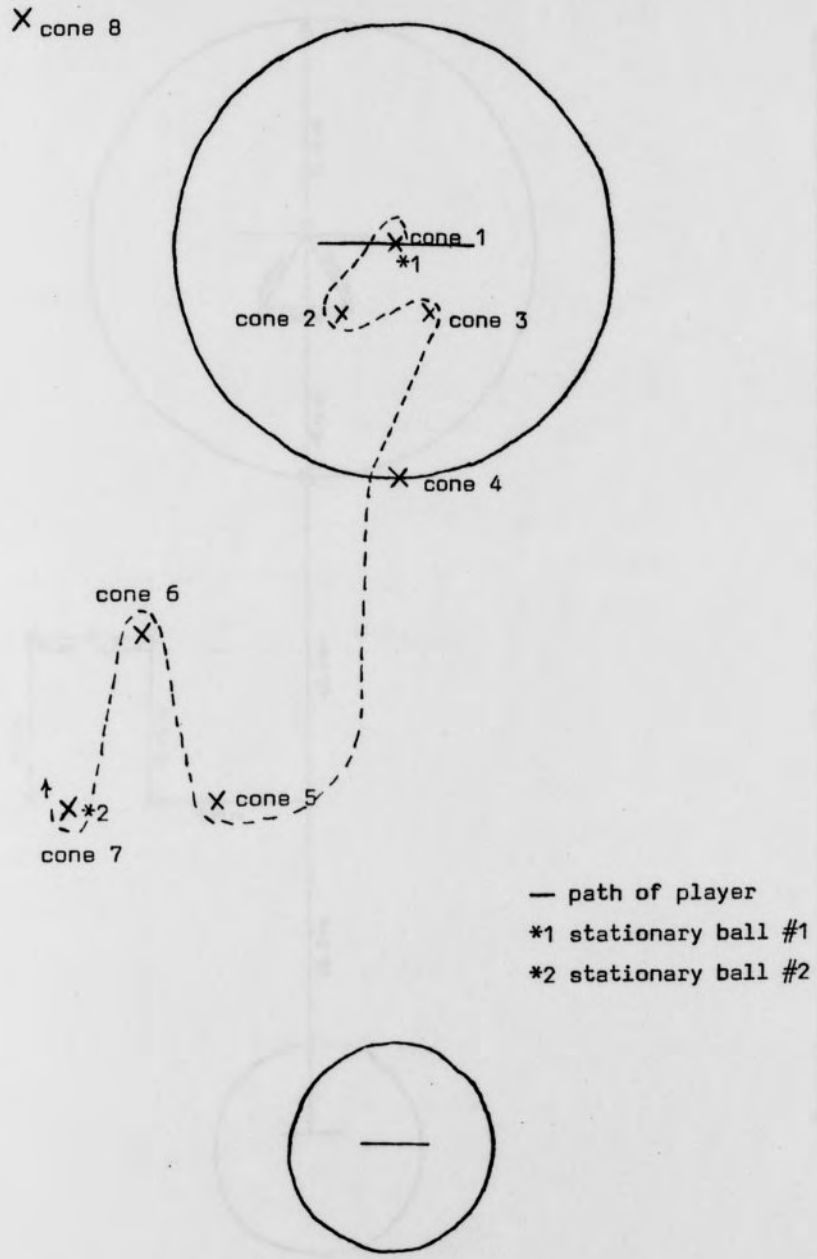


Figure 7. Cone positioning, ball placement, and path of player for Ennis Lacrosse test

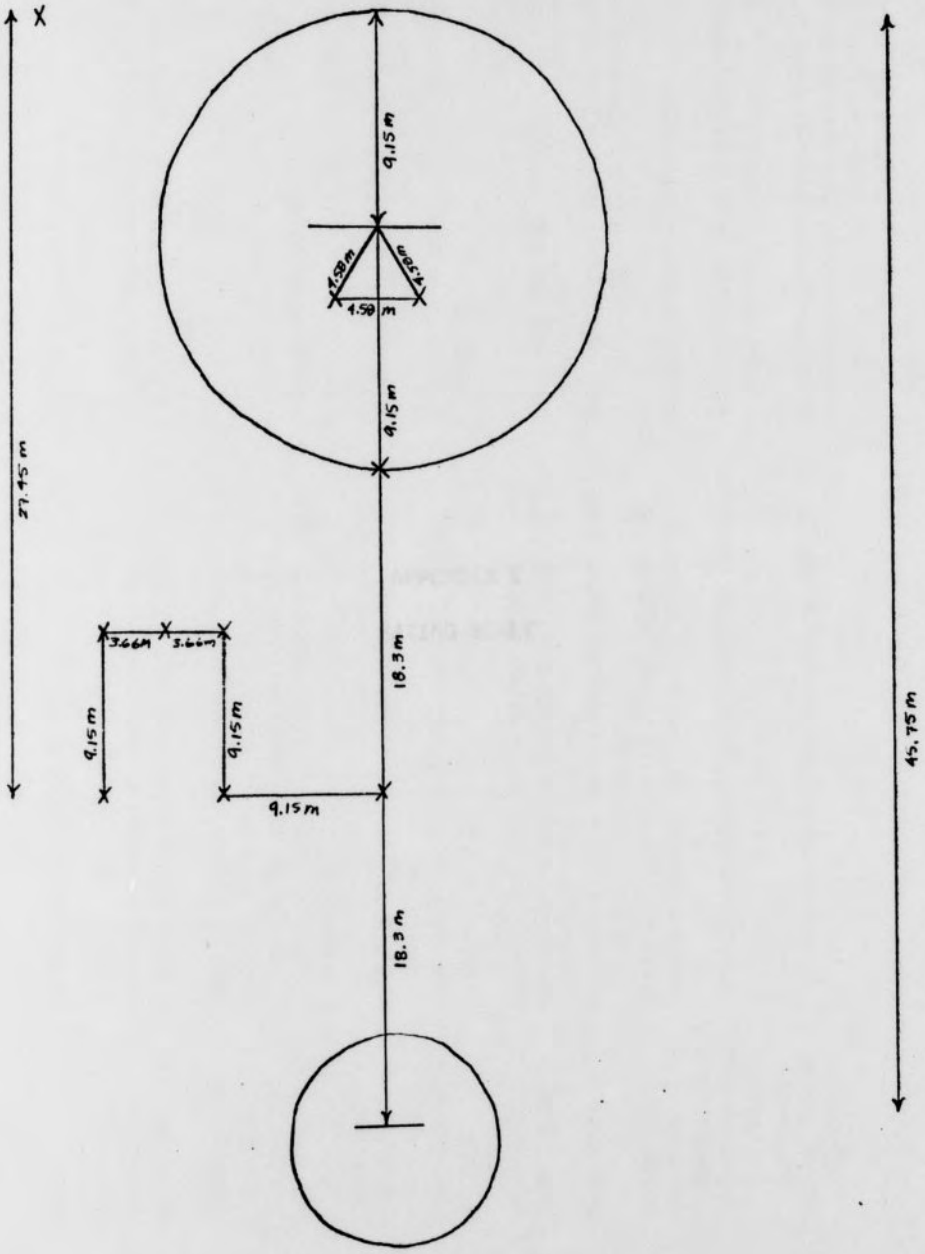


Figure 8. Field markings for Ennis lacrosse test

# APPENDIX E

## RATING SCALE

Ennis Revision of Hodges' Lacrosse Rating Scale

| Category | Skill | Hodges Rating Scale | Additional Criteria |
|---|---|---|---|
| A | Cradling | smooth, well-timed, ball under control | |
| | Picking up | accomplished with ease and control | cradles immediately; consistently |
| | Catching | accomplished with ease and control | equally well on both right and left; consistent |
| | Passing | pass is accurate and well timed | |
| | Evading Opponents | dodges, pivots or otherwise evades opponents with ease and control | |
| | Shifting from Offense to Defense | shifts immediately when opponent gets the ball | anticipates shift |
| | Field Positioning | effectively makes space for self or teammate | defensively positions goal side; positions for interception |
| | Body Control | has excellent control; rarely fouls | can stop, start, change direction quickly |
| B | Cradling | fairly smooth, ball under control | |
| | Picking up | is successful, but does not gain full control immediately | does not cradle until in an upright position |
| | Catching | is successful, but does not gain full control immediately | may experience difficulty consistently catching on the left |
| | Passing | pass is accurate, but not well-timed | |
| | Evading Opponents | evades opponents fairly effectively | dodges with acceleration |
| | Shifting from Offense to Defense | shifts quickly from offense to defense | may hesitate when shifting due to lack of anticipation |
| | Field Positioning | is fairly effective in making spaces | Offensively-not always aware of cutting priority; defensively - usually marks opponent closely, interceptions may not be well-timed |
| | Body Control | has body control; seldom fouls | may hesitate when stopping, starting, changing direction; checking is controlled |

Ennis Revision of Hodges' Lacrosse Rating Scale
(continued)

| Category | Skill | Hodges Rating Scale | Additional Criteria |
|---|---|---|---|
| C | Cradling | movements not absolutely synchronized, but maintains possession of the ball | |
| | Picking up | experiences difficulty but eventually successful | usually consistent |
| | Catching | has difficulty controlling the ball | may not cradle immediately |
| | Passing | gets free to make pass, but pass is not accurate | |
| | Evading Opponent | is checked in the evading attempt, but maintains possession of the ball | may slow down before dodging |
| | Shifting from Offense to Defense | shifts, but not soon enough | may temporarily lose opponent |
| | Field Positioning | tries to make spaces, but cuts in the wrong direction | defensively may mark opponent loosely; hesitates; interception unsuccessful |
| | Body Control | has body control; fouls infrequently | dodges and directional changes lack precision |

Ennis Revision of Hodges' Lacrosse Rating Scale
(continued)

| Category | Skill | Hodges Rating Scale | Additional Criteria |
|---|---|---|---|
| D | Cradling | characterized by jerky movements | frequently drops ball under pressure |
| | Picking up | does not gain control; pushes ball along the ground | |
| | Catching | ball hits the stick, but bounces off | does not cradle immediately |
| | Passing | tries to make the pass when marked too closely; passes just to get rid of the ball | |
| | Evading Opponents | attempts to evade opponents but loses the ball | when dodging, may turn back on opponent when inappropriate |
| | Shifting from Offense to Defense | is very slow in shifting | frequently loses opponent |
| | Field Positioning | crowds teammate who has the ball | |
| | Body Control | usually has body control; fouls occasionally | frequently lacks ability to change direction when running |
| E | Cradling | does not cradle | frequently does not cradle |
| | Picking up | completely misses the ball | frequently misses the ball |
| | Catching | completely misses the ball | frequently misses the ball |
| | Passing | drops the ball or makes a poor pass | frequently drops the ball or makes a poor pass |
| | Evading Opponents | does not attempt to evade opponents | stops; does not attempt to evade opponent |
| | Shifting from Offense to Defense | does not shift at all when opponent gets the ball | |
| | Field Positioning | stands in one place; does not cut to make spaces | defensively does not mark opponent |
| | Body Control | lacks body control; fouls often | inability to change direction when running |

# APPENDIX F

# COMPUTER PROGRAMS

Access to Repeated Measures ANOVA

Statistical Analysis System (1976)

```
DATA THESIS;
INPUT ID 1-2 S 3-4 LEVEL 5 TRIAL 6 TIME 7-9 1;
CARDS;

PROC PRINT;
TITLE RAW DATA;
PROC SORT;
BY LEVEL S TRIAL;

PROC ANOVA;
CLASSES LEVEL S TRIAL;
MODEL TIME = LEVEL S(LEVEL) TRIAL TRIAL*LEVEL;
TEST H=LEVEL E=S(LEVEL);
TITLE TWO WAY ANOVA RMD - ONE BETWEEN AND ONE WITHIN - ALL FIXED EFFECTS;

PROC SORT;
BY LEVEL TRIAL;
PROC MEANS N MEAN STD MIN MAX VAR;
BY LEVEL TRIAL;
VARIABLES TIME;
TITLE DESCRIPTIVE STATISTICS BY LEVEL AND TRIAL;

PROC SORT;
BY LEVEL;
PROC MEANS N MEAN STD MIN MAX VAR;
BY LEVEL;
VARIABLES TIME;
TITLE DESCRIPTIVE STATISTICS BY LEVEL;

PROC SORT;
BY TRIAL;
PROC MEANS N MEAN STD MIN MAX VAR;
BY TRIAL;
VARIABLES TIME;
TITLE DESCRIPTIVE STATISTICS BY TRIAL;
```

Access to Discriminant Analysis

Statistical Package for the Social Sciences (1975)

```
RUN NAME          DISCRIMINANT ANALYSIS
VARIABLES LIST    ID,S,LEVEL.TRIAL,TIME
INPUT FORMAT      FIXED(2F2.0,2F1.0,F3.1)
N OF CASES        95
INPUT MEDIUM      CARD
DISCRIMINANT      GROUPS=LEVEL(1,5)/VARIABLES=TIME/ANALYSIS=TIME/
                  FUNCTIONS=1/
OPTIONS           5,6,7,8,11,12
STATISTICS        1,2,5,6
READ INPUT DATA

FINISH
```

Access to Kendall Rank Correlation Coefficient

Statistical Analysis System (1976)

```
DATA THESIS;
INPUT ID 1-2 S 3-4 LEVEL 5 TRIAL 6 TIME 7-9 1;
CARDS;

PROC CORR KENDALL;
VARIABLES LEVEL TIME;
```

# APPENDIX G

## RAW DATA

Table 14

Raw Data: Level A

| N | Trial 1 | Trial 2 | Trial 3 | Mean Score |
|---|---|---|---|---|
| 1 | 25.6 | 22.7* | 23.6 | 23.96 |
| 2 | 21.6* | 22.0* | 21.3* | 21.63 |
| 3 | 22.7* | 23.0* | 21.0* | 22.23 |
| 4 | 24.0 | 23.0* | 23.2 | 23.40 |
| 5 | 27.0 | 26.2* | 26.3* | 26.50 |
| 6 | 23.8 | 24.2* | 25.4 | 24.46 |
| 7 | 24.5* | 24.2 | 24.2 | 24.30 |
| 8 | 25.7* | 26.7 | 26.2 | 26.20 |
| 9 | 26.3 | 25.2 | 24.0* | 25.17 |
| 10 | 24.3* | 24.5* | 23.8* | 24.20 |
| 11 | 23.7 | 23.8* | 23.5* | 23.67 |
| 12 | 23.4 | 23.4* | 23.2* | 23.33 |
| 13 | 28.5* | 26.2 | 26.7* | 27.13 |
| 14 | 23.2* | 22.2* | 23.3 | 22.90 |
| 15 | 29.8 | 29.0 | 27.7 | 28.83 |
| 16 | 25.0 | 23.3* | 27.3 | 25.20 |
| 17 | 26.5 | 27.8* | 22.8* | 25.70 |
| 18 | 22.3* | 22.7 | 21.2 | 22.07 |
| 19 | 23.4* | 24.2 | 24.2* | 23.98 |

* 1 second deduction - successful shot on goal

Table 15

Raw Data: Level B

| N | Trial 1 | Trial 2 | Trial 3 | Mean Score |
|---|---|---|---|---|
| 20 | 27.5 | 24.1* | 23.2* | 24.93 |
| 21 | 25.8* | 24.8* | 23.4* | 24.67 |
| 22 | 27.1 | 25.4 | 24.1 | 25.53 |
| 23 | 26.6* | 24.9* | 26.0 | 25.83 |
| 24 | 25.2 | 26.7 | 24.5* | 25.47 |
| 25 | 24.5* | 27.6 | 26.8* | 26.30 |
| 26 | 27.6 | 29.2 | 27.7 | 28.17 |
| 27 | 22.5* | 23.6* | 22.4* | 22.83 |
| 28 | 28.7 | 25.0* | 27.7* | 27.13 |
| 29 | 26.0* | 24.0* | 25.0* | 25.00 |
| 30 | 26.5* | 25.5* | 22.0* | 24.67 |
| 31 | 26.2* | 26.4 | 28.0 | 26.87 |
| 32 | 25.0* | 26.9 | 25.1 | 25.67 |
| 33 | 31.1 | 29.1 | 26.7 | 28.97 |
| 34 | 25.2* | 25.2 | 22.6* | 24.33 |
| 35 | 24.9 | 25.5* | 22.7* | 24.37 |
| 36 | 24.4* | 26.1* | 24.5 | 25.00 |
| 37 | 24.2* | 23.1* | 22.7* | 23.33 |
| 38 | 24.8* | 24.6* | 22.2* | 23.87 |

* 1 second deduction - successful shot on goal

Table 16

Raw Data: Level C

| N | Trial 1 | Trial 2 | Trial 3 | Mean Score |
|---|---|---|---|---|
| 39 | 26.6 | 22.7* | 23.2* | 24.17 |
| 40 | 24.4* | 23.8 | 22.0* | 23.40 |
| 41 | 29.2 | 27.0 | 28.5 | 28.23 |
| 42 | 29.2 | 28.4 | 27.5 | 28.37 |
| 43 | 31.3 | 29.5* | 29.4 | 30.07 |
| 44 | 27.8* | 30.0 | 28.3 | 28.70 |
| 45 | 29.0* | 27.4* | 27.4* | 27.93 |
| 46 | 31.9 | 34.9 | 25.5* | 30.77 |
| 47 | 25.5* | 34.2 | 33.4* | 31.03 |
| 48 | 25.7* | 27.0 | 22.9 | 25.20 |
| 49 | 30.0 | 26.8 | 24.7* | 27.17 |
| 50 | 29.0* | 25.0* | 24.6 | 26.20 |
| 51 | 34.8* | 32.5* | 28.8* | 32.03 |
| 52 | 28.3 | 26.1 | 26.4* | 26.93 |
| 53 | 22.5 | 23.7 | 23.8 | 23.33 |
| 54 | 27.2 | 26.2 | 23.1 | 25.50 |
| 55 | 30.7 | 26.2 | 24.2 | 27.03 |
| 56 | 34.1 | 25.9 | 26.8 | 28.93 |
| 57 | 29.8 | 25.4* | 25.4 | 26.87 |

* 1 second deduction - successful shot on goal

Table 17

Raw Data: Level D

| N | Trial 1 | Trial 2 | Trial 3 | Mean Score |
|---|---|---|---|---|
| 58 | 33.0* | 27.8 | 33.6* | 31.47 |
| 59 | 28.6 | 29.4* | 26.5* | 28.17 |
| 60 | 27.9* | 30.2* | 28.6 | 28.90 |
| 61 | 29.9 | 28.1* | 26.1* | 28.03 |
| 62 | 24.1 | 24.2 | 30.2 | 26.17 |
| 63 | 27.0* | 33.8 | 28.4 | 29.73 |
| 64 | 36.2 | 25.5 | 28.6* | 30.10 |
| 65 | 24.6* | 34.6 | 26.9 | 28.70 |
| 66 | 27.9* | 31.5 | 33.5* | 30.97 |
| 67 | 31.1* | 29.3 | 28.0* | 29.46 |
| 68 | 29.6* | 29.5 | 28.5 | 29.20 |
| 69 | 26.1 | 23.2* | 24.6* | 24.63 |
| 70 | 30.1* | 26.2 | 25.2* | 27.17 |
| 71 | 30.8 | 32.0 | 30.4 | 31.07 |
| 72 | 30.0* | 26.1 | 26.4 | 27.50 |
| 73 | 34.9* | 26.9* | 26.3* | 29.37 |
| 74 | 27.1* | 30.3 | 28.2 | 28.53 |
| 75 | 29.8* | 30.1 | 26.3* | 28.73 |
| 76 | 27.9 | 28.4 | 25.7* | 27.33 |

* 1 second deduction - successful shot on goal

Table 18

Raw Data: Level E

| N | Trial 1 | Trial 2 | Trial 3 | Mean Score |
|---|---|---|---|---|
| 77 | 31.4 | 37.5* | 34.4 | 34.43 |
| 78 | 57.0 | 35.1 | 37.2 | 43.10 |
| 79 | 47.7* | 40.2* | 29.0 | 38.97 |
| 80 | 34.2 | 30.1 | 35.2* | 33.17 |
| 81 | 30.2 | 31.7 | 28.5 | 30.13 |
| 82 | 30.2* | 27.2* | 28.8 | 28.73 |
| 83 | 35.2 | 35.4 | 30.2 | 33.60 |
| 84 | 33.0* | 27.1 | 26.1 | 28.73 |
| 85 | 34.0 | 30.7* | 33.4* | 32.70 |
| 86 | 29.5* | 27.1* | 37.3 | 31.30 |
| 87 | 38.3 | 33.0 | 30.9 | 34.07 |
| 88 | 40.5 | 31.2 | 29.6* | 33.77 |
| 89 | 32.0 | 32.5* | 32.7* | 32.40 |
| 90 | 32.2* | 33.2* | 30.7* | 32.03 |
| 91 | 32.8 | 30.0* | 31.0 | 31.27 |
| 92 | 33.5* | 31.6* | 35.1* | 33.40 |
| 93 | 31.2* | 37.2* | 35.8 | 34.73 |
| 94 | 36.7* | 30.3* | 31.4* | 32.80 |
| 95 | 29.2* | 30.7 | 30.7* | 30.20 |

* 1 second deduction - successful shot on goal

# APPENDIX H

## RELIABILITY FORMULA

$$R = \frac{(E - 1)}{(E - 1) + k}$$

Figure 9. Formula for Computing an Estimation of Reliability (Ebel, 1951, p. 413)